

**AUERBACH ON
AUTOMATIC
PHOTOCOMPOSITION**

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AUERBACH ON

AUTOMATIC PHOTOCOMPOSITION



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PREFACE

This volume is one of a series of books covering developments in the information science industry. *AUERBACH on Automatic Photocomposition* describes the principal classes of automatic photocomposers and their use in photocomposition systems. Typical examples are described in some detail; comparison charts extend the coverage to systems not so described.

Phototypesetters were originally intended as replacements for hot-metal composing machines such as the linotype or monotype. Although most of them contained built-in computing circuitry, they did not use external computers. It was the rapid growth of the electronic data processing industry in the 1960s and the outstanding success of computers in handling many repetitive business computations that led typographers to attempt computerization of typographic tasks.

These attempts were generally successful. Some of the computerized systems utilized hot-metal machines as type producers, but the rapid introduction of automatic photocomposers has caused increased interest in systems employing photographic techniques. The original systems had to use existing photocomposers, that is, photocomposers not originally intended for computer control. Later developments provided machines especially designed for computerized systems, making the photocomposer a true computer peripheral.

All of the machines described in this book can be controlled by computers or computer-produced tapes. Some can also be controlled manually, while some offer a combination of manual and computer control. For the sake of completeness and to give an adequate overview of the entire field, all major types of machines are treated.

AUERBACH on Automatic Photocomposition is an expansion of material from *AUERBACH Graphic Processing Reports*, a major unit in the *AUERBACH Computer Technology Reports*. They are prepared and edited by the publisher's staff of professional EDP specialists.

Material in this volume was prepared by the staff of AUERBACH Info, Inc. and has been updated prior to publication. The field is changing so rapidly, however, that the completeness of its contents cannot be guaranteed. For current information on computer technology, please refer to *AUERBACH Computer Technology Reports*. Information can be obtained from AUERBACH Info, Inc., 121 North Broad Street, Philadelphia, Pa. 19107.

**AUERBACH ON
AUTOMATIC
PHOTOCOMPOSITION**

1. DEVELOPMENT OF AUTOMATIC PHOTOCOMPOSITION

In recent times, the requirements and need for high volumes of printing have placed much pressure on the printing industry to develop faster and more efficient ways in which to produce printed matter. The advent of computers and the rapid growth of information produced by them was, and is, a significant factor in the growth of these printing requirements. The printing industry thus looked to computers to help solve its problems by streamlining the composition process, which is the printers' bottleneck. Automatic photocomposers were the result.

Automatic photocomposition is a direct outgrowth of conventional typographic composition, the effective beginning of which is usually acknowledged as the invention of printing methods using movable type perfected by Johann Gutenberg about the middle of the fifteenth century. Movable type consists of individual letters carried on pieces of metal so that the letters form a reversed relief image on the metal. In handset composition, introduced by Gutenberg and still in wide use throughout the world, the copy is composed by placing individual pieces of type into lines. The lines of composed type are then arranged to form a page. An inked roller is rolled across the composed page, covering the raised portions of type with ink. A sheet of paper is pressed against the inked type, transferring the image to paper.

Most aspects of raised-type printing have been greatly improved since Gutenberg's time. As far as composition is concerned, the biggest advance was undoubtedly the invention of the linotype by Ottmar Mergenthaler in 1885. This machine made high-volume printing possible by casting com-

plete lines of type under the control of an operator. The operator composed the copy at the keyboard of the machine.

Other mechanical typesetters had been invented before the linotype, but they attempted to compose a line by mechanically positioning individual pieces of type. The basic problem of mechanically sorting and storing the pieces of type for reuse was never satisfactorily solved. By casting lines of type instead of assembling individual pieces, the linotype minimizes this problem because the slugs can simply be melted down for recasting. Only the matrices in which the slugs were cast need be sorted. Since these can be sorted and reused immediately after each line is cast, the number that must be stored and handled is relatively small. The mechanical sorting mechanism is simple and reliable.

Casting methods have dominated typographic composition up to the present day and are still widely used. Their long-term success is evidence of their basic soundness. However, increased demands made upon typesetters in recent times have pointed out four ways in which casting methods do not fulfill modern requirements as completely as they met the needs of printers in the recent past.

1. Their speeds, although fast by comparison with handset methods, are slow by comparison with modern electrically operated equipment.

2. Their construction, since it must include a mechanism for handling molten type metal, makes them acceptable in a shop but unsuitable for installation in an office or laboratory.

3. Their typographic output, which is easily made up into standard textual pages, is difficult to incorporate in complicated pages and unusual layouts where all the type is not positioned in neat horizontal lines. This is particularly true of the cast lines produced by the linotype, which often must be sawed and shimmed to fit them into complicated layouts.

4. There is a tendency for ink to spread when paper is pressed against inked type. This reduces the sharpness of the characters.

KINDS OF TYPESETTING MECHANISMS

Automatic Linecasters

Increases in linotype speed can be obtained by improving the basic machine and by substituting tape control for direct keyboarding. Devices to accomplish the latter have been available since the introduction of the first teletypesetter in 1927. In recent years the use of automatic linecasters has increased because they provide—

- a. Greater typing speed, since keyboarding at a tape perforator is faster than at the linotype's keyboard.
- b. A larger pool of operators, since the keyboard of a tape perforator is basically the same as the keyboard of a typewriter.
- c. Remote control of the linotype by transmission of the coded copy over standard communication lines.
- d. Setting of repetitious matter without rekeyboarding by merely re-running the tape upon which it has been encoded.

It is even possible to keyboard the copy onto tape without dividing it into lines. Special devices automatically make the needed line divisions and prepare a tape to control the linotype.

Improvement as far as the other three deficiencies of casting are concerned is difficult with machines that compose in type metal. Even the speed improvement resulting from tape control is not enough to produce speeds that are compatible with modern computers, used increasingly in the preparation and organization of data. A change in the basic character-production system is needed to effect anything like the degree of improvement desired.

Photoengraving

There are good reasons why typographers, in considering alternatives to composing in type metal, looked favorably upon photographic methods. Since the development of photoengraving in the latter years of the nineteenth century, illustrations have been prepared for printing by this method. The process consists of photographing images to be printed, stripping the developed photograph onto a metal plate so that the images to be printed are protected by a hardened emulsion, and etching away the unprotected areas in a series of acid baths. This process produces a relief image that can be printed.

This system can produce a printing plate from a line drawing and can also etch letters onto a printing plate. In fact, the lettered labels that often appear on line drawings are usually treated as part of the drawing for plate-making purposes. The process for halftones is not that simple, since a ruled screen through which the halftone is photographed adversely affects letters.

If the letters that make up labels on a line drawing can be prepared for printing by photoengraving, it follows that a page of type can be similarly prepared. And since a photographic copy of the page is an intermediate stage in the photoengraving process, the desirability of a device that would typeset lines of copy directly onto photographic film is apparent. Such a machine, if properly conceived and constructed, could be expected to be

faster and cleaner than a type caster, thus making improvement in the first two of the four casting deficiencies listed.

Makeup of complicated pages could also be simplified, since lines of type on film or paper could be canted more easily than lines of type on metallic slugs. In practice, this advantage is somewhat offset by the fact that linotype slugs are sometimes more easily made up into standard textual pages, and are usually easier to revise and correct.

As far as quality is concerned, photographically produced characters tend to be sharper than cast metallic characters. This is even more true as the matrices from which metallic type is cast become damaged by their frequent contact with molten metal under pressure.

The fact that photographic production of typeset lines could thus be proved desirable did not, of course, guarantee the appearance of satisfactory photocomposing machines. The actual machine development was a painstaking process in which the designers were helped by the rapid development of electrical computational techniques after World War II, but were hindered by the necessity of waiting for or developing improvements in numerous components and ancillary processes. Details will not be given here. The existence of the automatic photocomposing machines is evidence of successful machine design, and their increasing use is evidence that the essential improvements in the ancillary processes have been made. In some of these, particularly in plate making, developmental work is continuing.

It is important to give some consideration to two methods, other than letterpress, by which large numbers of high-grade copies can be produced. These processes, although developed long before automatic photocomposition was seriously considered, did give considerable impetus to its development. The two methods are lithography and gravure.

Letterpress, Gravure, and Lithography

Letterpress, gravure, and lithography are usually compared by describing the methods by which each produces characters. A letterpress copy is made by alternately rolling ink over raised images of the characters and pressing paper against them. The raised portions of the metal transfer ink to the printed page; the depressed portions do not. In the gravure process, by contrast, the characters are etched into the surface of the plate to form depressed images. Ink is rolled over the surface, filling the depressions that form the image of the page, the surplus ink is scraped off the surface so that only the depressed portions retain ink, and paper is pressed against the plate to receive the image. In lithography, the characters are carried on the plate as flat, water-repellent images. A wet roller is rolled over the surface, which will dampen the nonprinting portions of the plate but will

not dampen the printing portions. The ink roller, which carries a greasy ink, is then passed over the plate. The ink will be repelled by the wet (non-printing) portions of the plate, but will adhere to the dry (printing) portions to form an inked image of the page. This image is transferred to paper, either directly by pressing the paper against the plate, or, more commonly, indirectly via a rubber offset roller.

The practical implementation of gravure and lithography is, of course, far more complicated than this superficial treatment of their operating principles might imply. The reason the processes are mentioned here is that each of them requires type on film at some place during the preparation of plates. In the early days of these processes, this was not true. Indeed, it could not have been true, since the basic processes were introduced before the invention of photography. However, although it is possible to hand-letter copy with a greasy pencil (in the case of lithography) or to hand-carve it into the metal plate (in the case of the gravure), and although such methods are used even today in special situations, the need for such painstaking procedures would eliminate both processes from consideration for most applications. The challenge that these processes make to the older letterpress process for high-volume work had to await the development of an adequate substitute for hand lettering.

Photographic Techniques

The substitute for hand work was provided by the development of photographic techniques. Attempts to produce lithographic and gravure plates photographically were started very soon after the invention of photography, and they have been so successful that a photograph of the typeset page on a transparent medium has become a standard intermediate in normal production work. This has traditionally been obtained by photographing a proof page that has been carefully printed from metallic type.

It is easy to understand why users of lithography and gravure are particularly interested in automatic photocomposition. They see that pages that would otherwise have to be obtained by casting metallic type and photographing the reproduction proofs can be produced directly on film. Even if automatically making up the complete page on film is beyond the capacity of the photocomposer (and it is beyond the capacity of many present machines unless the page design is very simple), a reproduction proof from which a page can be photographed can be prepared by phototypesetting the text in galley form on paper, and cutting and pasting the galleys into camera-ready copy. This process is usually cheaper, faster, and more flexible than the traditional method using metallic type, and the quality of the reproduction proofs is higher, since there is no ink spread.

Process Competition

Ever since the development of lithography and gravure as alternatives to letterpress, there has been competition for the printing dollar. Each of the three processes has its partisans and its detractors. Probably none will ever completely displace the others. In recent years, however, lithography has clearly displaced letterpress in a large number of applications. Today, it accounts for more than half of the commercial printing sales dollar in America. For example, 75 percent of American books were printed by lithography in 1968, compared with fewer than 25 percent only 14 years earlier.

Most of the increased market penetration has coincided with the increasing acceptance of photocomposition. While it would be an exaggeration to claim that photocomposition was the sole cause of the phenomenon, there can be little doubt that the perfection of photocomposition stimulated the use of lithography and that the availability of lithography stimulated the use of photocomposition.

The other printing processes have also made use of photocomposition. Many newspapers used it in connection with their rotogravure magazine supplements before they attempted to use it in the newspaper proper. Its use in letterpress printing was stimulated by the development of fast-etching procedures in the 1950s, which made it possible to produce letterpress plates quickly from photocomposed copy. In some letterpress newspapers, the first use of photocomposition combined with fast-etching plates was the typesetting of display advertisements, where the flexibility of photocomposition makes it particularly attractive. Development of plastic letterpress plates made it even easier and cheaper to go from photocomposed copy to a letterpress printing surface. Details of these processes need not be presented here, but it is interesting to observe that one of the main reasons for their development was the desire to make photocomposition commercially compatible with letterpress—an indication of the impact that has been made by the automatic photocomposers.

EARLY PHOTOCOMPOSITION SYSTEMS AND TECHNIQUES

Forerunners of Modern Photocomposers

Fotosetter

In 1949 the Intertype Company announced the Fotosetter. This was the first automatic phototypesetter that could make any serious attempt to com-

pete with a linecasting machine. At first glance, the Fotosetter looked like another linecaster, since it was basically an adaptation of an Intertype linecaster to phototypesetting purposes. Much of the basic linecaster mechanism was retained, but the linecaster matrices, which carry molds of the characters, were replaced by matrices that carried transparent negative images of the characters. Keyboarding the copy and assembling the matrices into a line were carried out in essentially the same manner as with a linecaster. However, instead of delivering the matrices to a casting mechanism and casting the entire line, the Fotosetter photographed the matrices, one by one, onto photographic film or paper. Distribution of the matrices back to their proper storage slots was accomplished in the same manner as in a linecaster. The film or paper was advanced between lines, and removed for development after a galley had been composed.

Photon

Meanwhile a group of publishers had furnished financial backing for the development of a photocomposer by Photon, Inc. Master characters were carried on a disk that rotated constantly in front of a flash lamp. When the desired character was in position, the lamp was automatically flashed, projecting the character onto the film. This combination of a rotating font and a stroboscopically controlled flash lamp has been used in later Photons and in a number of other photocomposers. Originally, the concept and basic method were developed in France by Louis Moyroud and René Higonnet.

The original Photon, introduced in 1954, combined the keyboard and the type-producing components into a single unit, which meant that its maximum operating speed was limited by the speed at which the keyboard could be operated. In later Photons, the keyboard unit was entirely separate, produced a perforated paper tape. The paper tape was then mounted on a reader and used to control the production of characters in a photographic unit.

Linofilm

In 1956 the Mergenthaler Linotype Company introduced their Linofilm, in which the two-unit concept was used. They also used an optical system that permitted the master characters to remain stationary during the time that they were being exposed onto the output material. Master characters were carried on grids that could be changed automatically when a font change was needed. Character selection was made by a shutter system that was controlled by the paper tape.

Production Elements

Galleys

These early systems all produced justified lines of phototypeset copy on long strips of photographic film or paper called *galleys*. The galleys were similar in appearance to the galley proofs produced by metallic composition, and were used to make up a page, as they are today. However, none of these early machines had automatic makeup capabilities, except to the extent that any machine that produces galleys is capable of performing some elementary makeup tasks. Even today, most machines are essentially galley producers. This is understandable, since galleys fit easily into the established operating procedure of the graphic-arts industry. Development of a practical system for general page makeup had to await the development of electronic data-processing techniques for quickly computing the makeup parameters.

Automatic Makeup

Once it became possible to compute quickly the position of each item on a page, the pressure increased to develop photocomposers that could typeset pages according to the computed positions. These machines, such as Mergenthaler's Linotron photocomposer, are computer slaves, completely dependent upon an external computer for their operating parameters, whereas the earlier galley producing machines performed internally the few computations that they needed.

In recent years there has been an increasing tendency to perform some typesetting computations on external computers for galley-producing photocomposers as well as for the page compositors, even though most galley-producing machines can be operated without them. The external computer relieves the keyboard operator of the task of dividing the copy into lines, thus increasing keyboarding speed and decreasing the skill level. It also makes possible the use of a large variety of keyboards with a photocomposer, since the tape produced by each keyboard can be converted by the computer into a tape capable of controlling the photocomposer. Thus, although most manufacturers of galley-producing photocomposers market keyboard units, some of which are especially designed for their photocomposing systems, the photocomposers can be controlled by other keyboards.

Potential Applications

No consideration of photocomposition would be complete if it failed to mention the stimulus afforded by the phenomenal growth of electronic data processing and the need to rationalize the method of publishing its output. To an increasing extent, the basic data for such important publications as census figures, business statistics, and scientific tables are prepared by a computer. In many other publications, such as catalogs and abstracts, the textual items, although not actually prepared by a computer, are often stored in an information storage system that includes a computer to retrieve them when they are needed. In either case, the computer delivers the information in coded form on magnetic tape. Therefore it can be typeset without keyboarding, although it usually must be subjected to further computer manipulation to adapt it for photocomposition.

The increasing amount of material that can control an automatic photocomposer without being keyboarded increases the interest in photocomposition. The high speeds at which the computer produces this material has further encouraged the development of faster photocomposers than would have been considered before the advent of the computer. These faster photocomposers, in turn, make it feasible to upgrade the appearance of a computer printout and to pack more output on a page without loss of legibility.

2. COMPARISON CHARTS

This chapter presents charts comparing the important characteristics of American automatic photocomposers. As in all comparison charts, only a limited number of features can be considered; consequently, this group of charts cannot present every detail of machine capability. Moreover, new machines are introduced frequently and older ones eliminated, so that no published table can remain completely current. And, since manufacturers not only introduce new machines but also sometimes modify existing ones, some of the individual items in these tables, although they were correct when the tables were compiled, may not be so at a later time.*

Despite their acknowledged limitations, comparison charts give the best overview of equipment. Further details can be obtained from manufacturers and their agents.

*The reader is advised that prices, especially, listed in these charts are not to be assumed literally. Only the manufacturers' listed prices at the time of purchase are official, and those shown in the charts should be considered as merely for comparative purposes.

IDENTITY	Alphatype	ATF Photocomp 20	Compugraphic CG 2961 TL Phototypesetter	Compugraphic CG 4961 TL Phototypesetter
REPORT NUMBER				
COMPOSING	Character Design Unit Horizontal Spacing Unit Vertical Spacing Unit	1/18 em 1/18 em 1/2 point	1/18 em 1/18 em 1/2 point	1/18 em 1/18 em 1/2 point
COMPOSING FLEXIBILITY	Max Single Line Advance Max Line Length Characters per Font Fonts Under Tape Control Character Capacity Point Size Range Tape Controlled Point Sizes	39-1/2 points 70 picas 84 2 (10 with Multimix*) 168 (840 with Multimix*) 40-18 1-2 (5-10 with Multimix*)	31-1/2 points 33 picas See Comments 4 (on 1 disc) 497 5-1/2-18 1 per font	31-1/2 points 45 picas 90 4 360 5-24 See Comments
COMPOSING SPEED	Max Tape Read Speed Characters per Second Newspaper Lines/Minute	10 char/sec 10 15	125 char/sec 11 20	125 char/sec 18 25
CHARACTER PRODUCTION	Character Storage Character Exposure Character Placement	Film character grids Flash lamp Output moves	Film strips Flash lamp Moving lens	Film strips Flash lamp Moving lens

INPUT/OUTPUT CHARACTERISTICS		Input	10-level mag tape; 6-, 7-level paper tape*	6-level paper tape	6-level paper tape	6-level paper tape; directed keyboarded text
CRT	Output	Film; paper; stabilization paper	Film; paper; stabilization paper	Stabilization paper	Stabilization paper	Stabilization paper
	Output Width	12 inches	3, 4, 5-3/4, 6 inches	3, 6, 8 inches	3, 6, 8 inches	3, 6, 8 inches
	Max Output Length	12 inches	75 feet	100 feet	100 feet	100 feet
PRICES, MACHINE, \$	Diameter	N/A	N/A	N/A	N/A	N/A
	Phosphor	N/A	N/A	N/A	N/A	N/A
	Spot Diameter	N/A	N/A	N/A	N/A	N/A
PRICES, MACHINE, \$		9,900 (printout) 6,600 (recorder and keyboard)	16,340	7,950	10,500	
PRICES, TYPE MASTERS, \$		65; 75	187.50	40	60	
PRICES, PRINCIPAL OPTIONS, \$		2,800 (paper tape - noncounting perforator) 4,300 (paper tape - counting perforator) 2,600 (multimix printout attachment) 1,900 (multimix recorder attachment)	750 (code converter) 295 (quadding option) 1,995 (endless tape option)	850 (wire service con-version) 65 (width plug) 50 (set gears)	2450 (DI keyboard) 850 (wire service con-version) 65 (width plug) 50 (set gears)	
COMMENTS			497 characters divided among 4 fonts	A second lens (2.4X) provided to alter point size; lenses switched manually	A second lens (2.4 X) provided to alter point size; lenses switched under tape control	

N/A - Not Applicable

• Optional

IDENTITY		AM 725 Phototypesetter	ATF B-8 Phototypesetter	Compugraphic CG 2900 Series Phototypesetters	Compugraphic CG 4961 Phototypesetter
REPORT NUMBER		70.105.01	70.005.01	70.019.01	70.019.02
COMPOSING QUALITY	Character Design Unit	1/18 em	1/18 em	1/18 em	1/18 em
	Horizontal Spacing Unit	0.001 inch	1/18 em	1/18 em	1/18 em
COMPOSING FLEXIBILITY	Vertical Spacing Unit	1/2 point	1/2 point	1/2 point	1/2 point
	Max Single Line Advance	49-1/2 points	16 points	31-1/2 points	31-1/2 points
COMPOSING SPEED	Max Line Length	See Comments	44-1/2 picas	33 picas	33 picas
	Characters per Font	112	88	90	90
	Fonts Under Tape Control	3	2	2	4
	Character Capacity	336	176	180	360
	Point Size Range	6-18	5-14	5-24	5-24
	Tape Controlled Point Sizes	1	1 (normal); 2 (max)	1	1
	Max Tape Read Speed	60 char/sec	10 char/sec	125 char/sec	125 char/sec
	Characters per Second	12	5-1/2	18	18
	Newspaper Lines/Minute	20	9	25	25
	Character Storage	Glass disc	Type disc	Film strips	Film strips
CHARACTER PRODUCTION	Character Exposure	Flash lamp	Shutter	Flash lamp	Flash lamp
	Character Placement	Moving type disc	Moving carriage	Moving lens	Moving lens

INPUT/OUTPUT CHARACTERISTICS		Input	6-, 7-, 8-level paper tape	8-level paper tape; manual keyboard	6-level (CG 2961), 7-level (CG 2971) paper tape	6-level paper tape; directly keyboarded text
CRT	Output	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper	Stabilization paper	Stabilization paper
	Output Width	4, 6 inches	3-3/4, 5-3/4, 7-3/4 inches	3-3/4, 5-3/4, 7-3/4 inches	3, 6 inches	3, 6 inches
	Max Output Length	150 ft	25 ft (paper); 40 ft (film)	25 ft (paper); 40 ft (film)	100 ft	100 ft
	Diameter	—	—	—	—	—
	Phosphor	—	—	—	—	—
	Spot Diameter	—	—	—	—	—
PRICES, MACHINE, \$		20, 500	About 20, 000	7, 950	10, 500	
PRICES, TYPE MASTERS, \$		375 (std) 550 (special)	325	40	60	
PRICES, PRINCIPAL OPTIONS, \$		\$22, 500 (machine with hyphenless justification — AM725H)		50 (set gears) 2, 200 (keyboard) 65 (width plug)	2, 450 (DI keyboard) 850 (wire service con-version) 65 (width plug) 50 (set gears)	
COMMENTS		Max line length: 36 picas (6 pts); 42 picas (7 pts); 45 picas (8-18 pts)		Price of basic machine includes 1 reader, 1 pair of set gears, 1 font strip, 1 line measure chart	Price of basic machine includes 1 reader, 1 font strip, 1 pair of set gears, 2 width plugs	

• Optional

IDENTITY		Fairchild PhotoTextSetter Synchroset 4000	Fairchild PhotoTextSetter 8100	Friden Justotext 70 Phototypesetter	Friden Photomix 70 Phototypesetter
REPORT NUMBER					
COMPOSING QUALITY	Character Design Unit Horizontal Spacing Unit Vertical Spacing Unit	15 widths per type turret 1/18 point 1/2 point	15 widths per type turret 1/18 point 1/2 point	1/5 em 1/5 em 1 point	1/36 em 1/6 point 1/2 point
	Max Single Line Advance Max Line Length Characters per Font Fonts Under Tape Control Character Capacity Point Size Range Tape Controlled Point Sizes	36 points 30 picas 108 2 216 5-18 12	32 points 30 picas 144 8 1,152 5-18 4	31 points 33 picas 90 2 180 5-12 1	31-1/2 points 47 picas 102 4 408 5-18 9
COMPOSING SPEED	Max Tape Read Speed Characters per Second Newspaper Lines/Minute	400 25 35	400 80 80-120	300 char/sec 15 30	More than 100 char/sec 15 32
	Character Storage Character Exposure Character Placement	Type turret Flash lamp Moving mirror	Film attached to drum Flash lamp Rotating drum	Film strips Flash lamp Moving lens	Film segments Flash lamp Fiber optics; moving lens

INPUT/OUTPUT CHARACTERISTICS		6-, 7-, 8-level paper tape	6-, 7-, 8-level paper tape	7-level paper tape	6-level paper tape
CRT	Input	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper
	Output	3, 4, 5, 6 inches	3, 4, 5, 6 inches	6 inches max	2, 3, 6, 8 inches
	Output Width	100 feet	100 feet (paper); 50 feet (film)	25 feet	25 feet
	Max Output Length	N/A	N/A	N/A	N/A
PRICES, MACHINE, \$	Diameter	N/A	N/A	N/A	N/A
	Phosphor	N/A	N/A	N/A	N/A
	Spot Diameter	N/A	N/A	N/A	N/A
PRICES, TYPE MASTERS, \$		22,500	42,440	5,950	20,950
PRICES, PRINCIPAL OPTIONS, \$		218.80	595	65	95
COMMENTS				75 (set gear)	

N/A - Not Applicable

IDENTITY		Fairchild Phototypesetter 2020	Intertype Fototronic 1200 Photographic Unit	Intertype Fototronic CRT	Mergenthaler Linofilm Super-Quick Machine
REPORT NUMBER		70.039.01	70.050.01	70.050.02	70.069.01
COMPOSING QUALITY	Character Design Unit	15 widths per turret type	1/32 em	1/160 em	1/8 point
	Horizontal Spacing Unit	1/9 point	1/64 em	1/20 point	1/8 point
COMPOSING FLEXIBILITY	Vertical Spacing Unit	1/2 point (to 18 points); 1 point (18-36 points)	1/4 point	0.1 point	1/4 point
	Max Single Line Advance	36 points	63-3/4 points	1,638 points	99-3/4 points
COMPOSING SPEED	Max Line Length	30 picas	51 picas	69 picas; 100 picas*	45 picas
	Characters per Font	108	120	Variable	96
COMPOSING PRODUCTION	Fonts Under Tape Control	2	10	Variable	4, 8 (std model); 8 (wide-range model)
	Character Capacity	216	1,200	4,096 max	384, 768 (std model); 768 (wide-range model)
COMPOSING PRODUCTION	Point Size Range	5-18	5-72	4-36	5-18 (std model); 5-72 (wide-range model)
	Tape Controlled Point Sizes	1	40 max	Variable	1/font (std model); 3/ font (wide-range model)
COMPOSING SPEED	Max Tape Read Speed	400 char/sec	20 char/sec	45 inches/sec	250 char/sec
	Characters per Second	20	20	6,000 max	30
COMPOSING PRODUCTION	Newspaper Lines/Minute	18	30	Variable	40
	Character Storage	Type turrets	Font discs	Digitized in memory	Grids
COMPOSING PRODUCTION	Character Exposure	Flash lamp	Spark gap	CRT	Shutter
	Character Placement	Moving mirror	Moving film carriage plus rotating prism	Beam deflection	Moving mirror

INPUT/OUTPUT CHARACTERISTICS		6-, 7-, 8-level paper tape	8-level paper tape	7-, 9-level magnetic tape	6-level paper tape
CRT	Output	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper; microfilm*	Film; paper; stabilization paper
	Output Width	3, 4, 5, 6 inches	3-3/4, 5-3/4, 7-3/4, 9-1/4 inches	18, 30, 42, 51, 69, 100* picas	4, 6, 8 inches
	Max Output Length	100 ft	—	500 ft	100 ft
	Diameter	—	—	10 inches	—
PRICES, MACHINE, \$	Phosphor	—	—	P11	—
	Spot Diameter	—	—	0.001 inch min	—
	PRICES, MACHINE, \$	17,950	65,000	322,500 (256-char capacity)	28,250 (std, 2-grid) 33,250 (std, 4-grid) 38,250 (wide-range)
PRICES, TYPE MASTERS, \$		218.80	875	12/char	175 (Class A grid, plug) 275 (Class B grid, plug)
PRICES, PRINCIPAL OPTIONS, \$		—	29,500 (keyboard) 14,750 (satellite keyboard)	22,500 (additional 256-char modules) 65,000 (100-pica line capacity)	1,250 (quad, center) 3,000 (tabulate) 1,600 (tape film advance) 1,500 (automatic line length change) 300 (line delete) 150 (optional cabinet)
COMMENTS					\$350 (computer module); grids, width plugs available separately; each grid contains 2 fonts

• Optional

IDENTITY		Graphic Systems C/A/T Phototypesetter	Intertype Fototronic TxT Phototypesetting System	Mergenthaler Linofilm KE-18, KE-28 Phototypesetters	Mergenthaler COL-28, DCI Phototypesetters
REPORT NUMBER					
COMPOSING QUALITY	Character Design Unit	1/36 em	1/32 em	1/18 em	1/18 em
	Horizontal Spacing Unit	1/6 point	1/32 em	2/9 em	2/9 em
	Vertical Spacing Unit	1/2 point	1/10 point	1 point	1 point
	Max Single Line Advance	Unlimited	99-9/10 points	48 points	48 points
COMPOSING FLEXIBILITY	Max Line Length	47 picas	42 picas	42 picas	42 picas
	Characters per Font	102	86-127	88	88
	Fonts Under Tape Control	4	up to 6	18 (KE-18); 28 (KE-28)	28
	Character Capacity	408	up to 508	1,584 (KE-18); 2,464 (KE-28)	2,464
	Point Size Range	5-18	5-36	6-54	6-54
	Tape Controlled Point Sizes	9	12	15	15
COMPOSING SPEED	Max Tape Read Speed	60 char/sec	125 char/sec	40 char/sec	250 char/sec
	Characters per Second	28	80	18-1/2	18-1/2
	Newspaper Lines/Minute	More than 50	90 to 150+	20	20
CHARACTER PRODUCTION	Character Storage	Film strips (see Comments)	Font discs	Glass grids	Glass grids
	Character Exposure	Flash lamp	Flash lamp	Flash lamp	Flash lamp
	Character Placement	Fiber optics; moving lens	Scanning mirror	Moving mirror	Moving mirror

INPUT/OUTPUT CHARACTERISTICS		Input	8-level, computer-generated paper tape	6-, 8-level paper tape; 9-level mag tape*	15-level paper tape	6-level paper tape (see Comments)
CRT	Output	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper
	Output Width	2, 3, 6, 8 inches	3-3/4, 5-3/4, 7-3/4 inches	3-3/4, 5-3/4, 7-3/4 inches	4, 6, 8 inches	4, 6, 8 inches
	Max Output Length	150 feet	475 feet (paper); 200 feet (film)	475 feet (paper); 200 feet (film)	100 feet	100 feet
CR	Diameter	N/A	N/A	N/A	N/A	N/A
	Phosphor	N/A	N/A	N/A	N/A	N/A
	Spot Diameter	N/A	N/A	N/A	N/A	N/A
PRICES, MACHINE, \$		16,900		49,750 with 1 lens	48,400 (KE-18) 49,400 (KE-28)	46,500 (COL-28) 39,500 (DCI)
PRICES, TYPE MASTERS, \$		190 (standard) 350 (nonstandard)		875	275 (standard) 400 (standard variant)	275 (standard) 400 (standard variant)
PRICES, PRINCIPAL OPTIONS, \$				425 (extra lens) 925 (dark booth) 1,850 (base line punch) 9,150 (mag tape reader)	18,850 (keyboard unit)	9,500 (6-level tape reader)
COMMENTS		Film strips permanently mounted on interchangeable segments				COL-28 also operable from 15-level paper tape

N/A - Not Applicable

• Optional

IDENTITY		Mergenthaler Linotron 505	Photon 713-5 Phototypesetter	Photon 713-5 Taskmaster I Phototypesetter	Photon 713-5 Taskmaster II Phototypesetter
REPORT NUMBER		70.069.02	70.078.01	70.078.01	70.078.01
COMPOSING QUALITY	Character Design Unit	1/18 em	1/36 em	1/36 em	1/36 em
	Horizontal Spacing Unit	1/650 in. (std def); 1/1300 in. (high def)	1/36 em	1/36 em	1/36 em
COMPOSING FLEXIBILITY	Vertical Spacing Unit	1/2 point	1/2 point	1/2 point	1/2 point
	Max Single Line Advance	63 points	31-1/2 points	31-1/2 points	31-1/2 points
COMPOSING SPEED	Max Line Length	64 picas	45 picas	45 picas	45 picas
	Characters per Font	238	96	96	96
	Fonts Under Tape Control	4	8	8	8
	Character Capacity	952	768	768	768
	Point Size Range	5-28; 5-72*	5-18	5-36	5-72
	Tape Controlled Point Sizes	15; 30*	2	8	16
	Max Tape Read Speed	210 char/sec	500 char/sec	500 char/sec	500 char/sec
CHARACTER PRODUCTION	Characters per Second	250 (8 pt, std def); 125 (8 pt, high def)	20	20	20
	Newspaper Lines/Minute	170 (std def); 140 (high def)	40	40	40
CHARACTER PRODUCTION	Character Storage	Glass character grids	Film strips	Film strips	Film strips
	Character Exposure	CRT	Flash lamp	Flash lamp	Flash lamp
	Character Placement	Moving mirror and grating	Moving mirror plus flash adjustment	Moving mirror plus flash adjustment	Moving mirror plus flash adjustment

INPUT/OUTPUT CHARACTERISTICS		Input	8-level paper tape; 6-level paper tape*; 7-, 9-level mag tape* Film; paper; stabili- zation paper	6-, 7-, 8-level paper tape	6-, 7-, 8-level paper tape	6-, 7-, 8-level paper tape
		Output	Film; paper; stabili- zation paper	Film; paper; stabili- zation paper	Film; paper; stabili- zation paper	Film; paper; stabili- zation paper
		Output Width	4, 6, 8, 11 inches	4, 6, 8 inches	4, 6, 8 inches	4, 6, 8 inches
		Max Output Length	100 ft	100 ft	100 ft	100 ft
CRT	Diameter	See Comments	—	—	—	—
	Phosphor	P24 blue (index CRT); P24 green (printout CRT)	—	—	—	—
	Spot Diameter	0.005 (index CRT); 0.005 (printout CRT)	—	—	—	—
PRICES, MACHINE, \$		103,600	22,000	28,250	29,250	
PRICES, TYPE MASTERS, \$		950	290 (std) 850 (custom)	290 (std) 850 (custom)	290 (std) 850 (custom)	
PRICES, PRINCIPAL OPTIONS, \$		26,500 (mag tape reader) 12,800 (keyboard) 4,000 (char monitor) 10,900 (univ tape adapt) 8,950 (pi attachment) 15,000 (wide range) 1,800 (var line start) 2,750 (math option)	4,950 (keyboard)	4,950 (keyboard)	4,950 (keyboard)	
COMMENTS		CRT diameters: 9 inches (index), 6 inches (std printout), 9 inches (wide-range printout)				

• Optional

IDENTITY		Mergenthaler V-I-P Phototypesetter	Photon 200B Phototypesetter	Photon 260 Phototypesetter	Photon 532 Phototypesetter
REPORT NUMBER		—	—	—	—
COMPOSING QUALITY	Character Design Unit	1/18 em	1/18 em	1/18 em	1/18 em
	Horizontal Spacing Unit	1/18 point	1/36 em	1/36 em	1/36 em at 24 points
	Vertical Spacing Unit	1/2 point	1/10 point	1/10 point	1/2 point
COMPOSING FLEXIBILITY	Max Single Line Advance	63-1/2 points	49-9/10 points	49-9/10 points	127-1/2 points
	Max Line Length	36 picas; unlimited with display option	54 picas	54 picas	54 picas
	Characters per Font	96	90	90	90
	Fonts Under Tape Control	6 (A range); 3 (B range)	See Comments	16	32
	Character Capacity	576 (A range); 288 (B range)	1,440	1,440	2,880
	Point Size Range	6-48; 28-96 with display option	5-72	5-72	4-1/2-72
	Tape Controlled Point Sizes	10 (6 additional with display option)	See Comments	12	23 max
	Max Tape Read Speed	60 char/sec	—	110 char/sec	200 frames/sec
COMPOSING SPEED	Characters per Second	20	8	10	15
	Newspaper Lines/Minute	32	—	14	25
CHARACTER PRODUCTION	Character Storage	Film strips	Glass font disc	Glass font disc	2 glass font discs
	Character Exposure	Flash lamp	Flash lamp	Flash lamp	Flash lamp
	Character Placement	Rotating mirror	Moving mirror plus flash adjustment	Moving mirror plus flash adjustment	Moving mirror plus flash adjustment

INPUT/OUTPUT CHARACTERISTICS		6-, 7-, 8-level paper tape (choice of one)	Directly keyboarded	6-, 8-level paper tape; direct keyboard	6-, 8-level paper tape
CRT	Output	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper
	Output Width	6-3/4 inches	4, 6, 8 inches	4, 6, 8 inches	4, 6, 8, 10 inches
	Max Output Length	100 feet; 70mm (display material)	100 feet (paper); 50 feet (film)	100 feet (paper); 50 feet (film)	100 feet (paper); 50 feet (film)
	Diameter	—	—	—	—
PRICES, MACHINE, \$	Phosphor	—	—	—	—
	Spot Diameter	—	—	—	—
		19, 500	49, 900	52, 400	54, 500
PRICES, TYPE MASTERS, \$		120	1, 025 (standard class)	1, 025 (standard class)	1, 025 (standard class)
PRICES, PRINCIPAL OPTIONS, \$		21, 500 (machine with display option)	—	—	—
COMMENTS		A-range grids cover 6-24 points; B-range grids cover 12-48 points	12 sizes controlled by keyboard; 16 fonts controlled by keyboard	Tape source: computers only	

IDENTITY		Photon 513, 560 Phototypesetters	Photon 561 Phototypesetter	Photon 902 Phototypesetter	Star Parts CompStar Phototypesetter
REPORT NUMBER		—	—	—	—
COMPOSING QUALITY	Character Design Unit	1/18 em	1/18 em	1/18 em	1/18 em
	Horizontal Spacing Unit	1/36 em	1/36 em at 24 points	1/13 em at 6 points	1/18 em
COMPOSING FLEXIBILITY	Vertical Spacing Unit	1/10 point	1/2 point	1/4 point	1/2 point
	Max Single Line Advance	49 points	127-1/2 points	15-3/4 inches	31-1/2 points
COMPOSING SPEED	Max Line Length	54 picas (wrong reading); 42 picas (right reading)	54 picas	66 picas	30 picas
	Characters per Font	90	90	88	90
	Fonts Under Tape Control	16	16	3	2
	Character Capacity	1,440	1,440	264	180
	Point Size Range	6-72	4-1/2 to 72	5-14	5-18
	Tape Controlled Point Sizes	12	12	Sizes on disc	1
	Max Tape Read Speed	110 frames/sec	250 frames/sec	3,080 char/sec	200 char/sec
	Characters per Second	10	10	800 char/sec max	75
	Newspaper Lines/Minute	14	25	900	130
CHARACTER PRODUCTION	Character Storage	Glass font disc	Glass font disc	Glass character grid	Film strips
	Character Exposure	Flash lamp	Flash lamp	Flash lamp	Flash lamp
	Character Placement	Moving mirror plus flash adjustment	Moving mirror plus flash adjustment	Reciprocating lens	Rotating mirror

INPUT/OUTPUT CHARACTERISTICS		Input	6-level paper tape; 8-level paper tape (560 only) Film; paper; stabilization paper	6-, 8-level paper tape Film; paper; stabilization paper	7 channel mag tape Film; paper; stabilization paper	6-level paper tape Film; paper; stabilization paper
CRT	Output Width	Output Width	4, 6, 8, 10 inches	4, 6, 8, 10 inches	4-12 inches	3-8 inches
	Max Output Length	Max Output Length	100 feet (paper); 50 feet (film)	100 feet (paper); 50 feet (film)	100 feet (paper); 50 feet (film)	150 feet
	Diameter	Diameter	—	—	—	—
	Phosphor	Phosphor	—	—	—	—
	Spot Diameter	Spot Diameter	—	—	—	—
	PRICES, MACHINE, \$	PRICES, MACHINE, \$	53,000 (513) 35,000 (560)	46,000	Available from manufacturer	11,990
	PRICES, TYPE MASTERS, \$	PRICES, TYPE MASTERS, \$	1,025 (std class)	1,025 (std class)	Available from manufacturer	60
PRICES, PRINCIPAL OPTIONS, \$		PRICES, PRINCIPAL OPTIONS, \$	—	—	—	—
COMMENTS		COMMENTS	560 tape must contain character widths			

IDENTITY		Photon 713-5 Combo Phototypesetter	Photon 713-10, 713-10 Headmaster 713-20 Phototypesetters	Photon 713-100, 713-200 Phototypesetters	RCA Videocomp Photocomposer 70/800
REPORT NUMBER		70.078.01	70.078.01	70.078.01	70.082.02
COMPOSING QUALITY	Character Design Unit	1/36 em	1/36 em	1/36 em	1/4, 800 inch
	Horizontal Spacing Unit	1/36 em	1/36 em	1/36 em	1/50 point
COMPOSING FLEXIBILITY	Vertical Spacing Unit	1/2 point	1/2 point	1/2 point	1/32 point
	Max Single Line Advance	31-1/2 points	31-1/2 points	31-1/2 points	256 points
COMPOSING SPEED	Max Line Length	—	45 picas (std); 90 picas (special)	90 picas	70 picas
	Characters per Font	96	96	96	80
	Fonts Under Tape Control	8	8	8	Variable
	Character Capacity	768	768	384	Variable
	Point Size Range	5-144	5-36; 5-72 (Headmaster)	5-36	4-96
	Tape Controlled Point Sizes	24	8; 16 (Headmaster)	8	8
	Max Tape Read Speed	500 char/sec	500 char/sec	500 char/sec	30,000 char/sec
CHARACTER PRODUCTION	Characters per Second	20	20	50 (713-100); 100 (713- 200)	6,000 max
	Newspaper Lines/Minute	—	40	100 (713-100); 200 (713- 200)	Variable
CHARACTER STORAGE	Character Storage	Film strips	Film strips	Film strips	Digitized in memory
	Character Exposure	Flash lamp	Flash lamp	Flash lamp	CRT
Character Placement		Moving mirror plus flash adjustment	Moving mirror plus flash adjustment	Moving mirror plus adjustment of flash time	Beam deflection

INPUT/OUTPUT CHARACTERISTICS		6-, 7-, 8-level paper tape	6-, 7-, 8-level paper tape	6-, 7-, 8-level paper tape	6-, 7-, 8-level paper tape	9-level magnetic tape
CRT	Input	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper	Film; paper; stabilization paper; microfilm*
	Output	4, 6, 8 inches	4, 6, 8 inches	4, 6, 8 inches	4, 6, 8 inches	70, 100, 150, 250, 310mm; 35mm*
	Output Width	100 ft	100 ft	100 ft	100 ft	400 ft
	Max Output Length	—	—	—	—	—
PRICES, MACHINE, \$	Diameter	—	—	—	—	7 inches
	Phosphor	—	—	—	—	P11
	Spot Diameter	—	—	—	—	0.008 inches
PRICES, MACHINE, \$		Negotiable	42,500 (713-10) 47,500 (713-20)	42,500 (713-100) 62,500 (713-200)	341,775	—
PRICES, TYPE MASTERS, \$		290 (std) 850 (custom)	290 (std) 850 (custom)	290 (std) 850 (custom)	12/character	—
PRICES, PRINCIPAL OPTIONS, \$		4,950 (keyboard)	1,500 (tape handler) 13,500 (mag tape reader) 6,930 (expanded memory) 9,950 (keyboard)	1,500 (tape handler) 13,500 (mag tape reader) 6,930 (expanded memory) 9,950 (keyboard)	38,250 (additional memory) 10,000 (console typewriter) 10,200 (full face writing) 9,600 (35mm micro-image)	—
COMMENTS		Produces continuous strip of output	713-10 accepts justified tape only; 713-2 accepts justified or unjustified tape	713-10 accepts justified tape only; 713-2 accepts justified or unjustified tape	32,710 (disc storage) 10,000 (image rotation) 20,000 (drawing writing) 24,000 (drawing scanning)	—

• Optional

3. PHOTOTYPESETTER CATEGORIES

The charts in Chapter 2 permit a quick comparison of the operating characteristics of photocomposers, but they cannot give much insight into their construction and operating principles. These principles are, of course, interesting in themselves; but in addition, an understanding of the basic nature of the different kinds of photocomposers makes possible a more intelligent use of comparison charts and other simplified summaries. For no matter how complete a summary chart may be, it cannot present all the distinguishing features of individual photocomposers, let alone the distinguishing features of the important machine types.

The operating principles of photocomposers may be presented in several different ways. The method used here is to describe in some detail the construction and operation of representative machines, that is, of machines that are good examples of specific machine types. The machines chosen are those whose description best clarifies the operating principles of the group. No implication that they are the best machines in their groups is intended.

For the purposes of this treatment, the field of automatic photocomposition is considered to comprise six machine categories:

1. Adaptations of justifying typewriters
2. Low-priced text machines
3. Optical character generators with rotating fonts
4. Optical character generators with stationary fonts
5. Electronic character generators with optical character storage
6. Electronic character generators with electronic character storage

Any classification scheme must, of course, be arbitrary to some extent, and this one is no exception. Nor are the categories completely free of overlap: Most of the machines in categories 1 and 2, for example, could also be placed in category 3. All six categories, however, are significant, and each helps to provide a comprehensive understanding of the total field of automatic photocomposition. Chapters 4 through 9 describe respectively the typical representations of categories 1 through 6.

In these categories a distinction between optical and electronic character generation is maintained. Optical generation is considered to be a process whereby the characters being phototypeset are projected from transparent masters onto photographic film or paper and positioned thereon by some mechanical means. This method, used on all early phototypesetters, is still the one employed in most modern versions.

However, some of the newer machines position characters electronically by producing them on the surface of a cathode-ray tube, very much as a television picture is produced in ordinary broadcast television. And, since the picture on a cathode-ray tube is produced by an electronic beam that strokes the tube rapidly with a large number of parallel lines, it becomes logical to store the characters themselves as a series of digital signals that will turn the beam on and off at the locations that will produce the characters on the face of the tube. (When the beam is on, the tube face glows at the spot where the beam strikes; when the beam is off, the face remains dark.) Such phototypesetters are said to have true electronic character generation.

Attempts to adapt these television techniques to typesetting were made early, even before the introduction of the initial optical phototypesetters. Unfortunately, the available television methods could not produce a sharp enough image to yield a satisfactory typeset page. Practical electronic character generation had to await the availability of high-resolution cathode-ray tubes, which were originally developed for such applications as aerial reconnaissance photography. Once these became available, the interest in electronic character generation grew rapidly. Today, although most of the photocomposers use optical character generation combined with mechanical character placement, there are an increasing number that employ electronic character generation, electronic placement, or both at some phase of their operation.

There is a tendency to use optical-mechanical methods at moderate speeds and electronic methods at high speeds, although a considerable overlap exists.

4. ADAPTATIONS OF JUSTIFYING TYPEWRITERS

Long before the development of automatic photocomposition, pages were composed by typewriter—a particularly effective method, even today, when offset lithography is used to prepare final copies. Indeed, numerous organizations typewrite their reports and manuals, reproduce them on their own offset duplicators, and bind the lithographed pages into a book for general distribution. However, the limitations imposed on type style and the lack of a convenient method of typing justified lines make it difficult to produce typewritten pages with a typeset look, and consequently make them unacceptable for much typographic composition.

Manufacturers have developed attractive typewriter fonts that produce lines with high resemblance to typeset ones, and they now offer typewriters with interchangeable fonts to increase flexibility. Tape-operated justifying typewriters have also boosted the use of typewritten composition in much high-quality typography, as has the increasing acceptance of unjustified (ragged right) lines. But in many situations the reliance on an impact-produced page has retarded the use of typewriter composition.

Tape-operated justifying typewriters do not qualify as true automatic photocomposers because they do not produce the output photographically. However, machines have been marketed which produce photocomposed galleys from the tapes produced by these typewriters. In effect, these machines use the typewriter as a keyboard for producing paper tape that can operate a photographic unit. They are not fast and have been supplanted in many applications by more complete photocomposition systems; but they are interesting to consider as a means of producing an auto-

matic photocomposer by marrying part of a justifying typewriter with a photo-optical method of character production. The American Type Founders (ATF) photographic unit, described below, is a typical example of this kind of composing system.

THE ATF OPTICAL PHOTOTYPESETTER

Characteristics of the Photographic Unit

The ATF Model B-8 photographic unit is an optical phototypesetter that can produce galleys of typeset material on photographic film, paper, or stabilization paper at about 5½ characters each second. Characters are projected optically from a type disk that contains two 88-character fonts.

Character selection and positioning are normally controlled by an input paper tape, but these operations can be also effected by a keyboard that is built into the unit. The manufacturer markets keyboards that prepare this tape. Tapes produced by many other keyboards, however, can be converted in a computer to make them suitable. Normally, only one point



Figure 4-1. The ATF B-8 Photographic Unit

size is produced from each type disk; however, disks can be ordered with two point sizes. Disks are easily changed during operation.

System Configuration

Figure 4-2 illustrates the system configuration for the ATF B-8 photographic unit. In one mode of operation, an eight-level paper tape is prepared at the ATF B-8 keyboard. This tape contains the copy, coded and divided into lines, with a code at the end of each line to indicate the inter-word spacing needed for justification of the line. The tape serves as input to the photographic unit, and the information extracted from it, along with the set widths and line advances that have been introduced by the operator, is used by the unit to produce justified typeset output on photographic film, photographic paper, or stabilization paper.

In another mode of operation, the copy can be originally coded at any one of a number of other keyboards, so that a computer can convert the coded copy into the eight-level paper tape that controls the photographic unit. A third mode of operation employs a keyboard, built into the photographic unit, that can input the copy directly. In this case, however, the output will not be justified; consequently, this mode of operation is not used for ordinary typesetting.

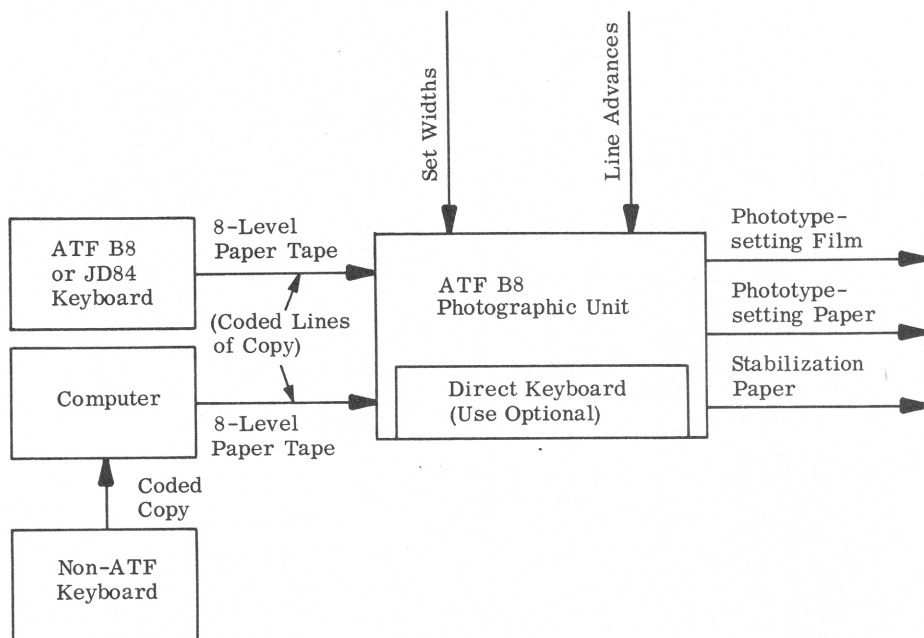


Figure 4-2. System Flow Diagram, ATF B-8 Photographic Unit

Set widths are entered on plugboards that give the widths of all the different characters on a particular type of disk. Two different line advances can be set in at the film carriage on the unit, either of which can be called for by the input tape. Output must be removed from the photographic unit for processing. Once processed, it serves as a good starting point for the production of plates for quantity reproduction by the various printing processes.

Mechanism Description

Optical phototypesetters, whatever their speed or complexity, produce typeset copy from master characters that are stored in the machine as transparent negatives (white characters on a black background). They

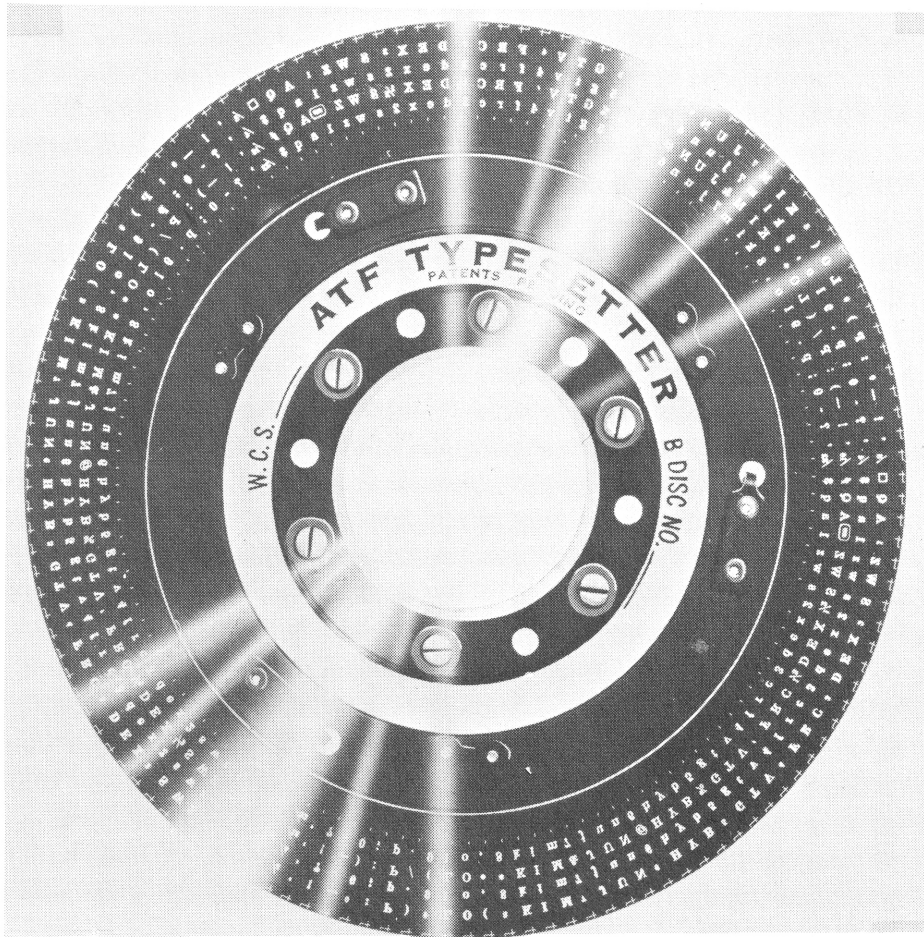


Figure 4-3. Type Disk for ATF B-8 Photographic Unit

include mechanisms for selecting the characters, imaging them on the output in the desired size, locating the images properly so that lines of typeset copy are produced, and separating the lines by the proper interline distance.

In the ATF B-8 photographic unit, the characters are stored on a rotatable type disk. (Figure 4-3) that carry 176 different characters in four rows. Characters are selected by rotating the disk until a group of four characters, one in each row, is in projection, and tilting two mirrors to select the desired one of the four. (Normally, the four are closely related, upper- and lower-case masters of the same character in roman and boldface, for example.)

The output medium is mounted on an escapement mechanism that is similar to the carriage drive of a proportional-spacing typewriter, but which is capable of finer incremental control. By means of this mechanism, the output is moved the proper amount between characters to allow for their set widths, thus locating the characters properly along the line. Tabulator stops, similar to those on a typewriter, are also provided. After a line of copy has been typeset, the output material (film or paper) is moved vertically the desired interline distance, the carriage returns to the start-of-line position, and composition of the next line begins.

Sequence of Operations

Fonts

Two fonts, each consisting of two rows of characters, are placed in one 120-degree sector of each font disk; the other two 120-degree sectors repeat the fonts. This arrangement permits higher operating speed by reducing the amount the disk must rotate between characters. Each row contains 44 characters per sector, corresponding to the 44 character keys on the keyboard. The two rows for each font correspond to the shift and unshift positions of the keys.

Exposure Mechanism

A drive mechanism constantly urges the disk to rotate through a slip clutch. A latch holds the disk stationary during character exposure. When the next character is to be typeset, the latch automatically releases to permit the disk to rotate counterclockwise until a fixed pin in the disk strikes a stop blade that has been extended in response to a character code sensed at the tape reader.

There are 44 stop blades arranged in an arc under the type disk. When

the disk stops, four characters in vertical array align with a slot in a mask when a rotating shutter opens, light from a lamp illuminates the characters. In Figure 4-4, the four illuminated characters are lower-case roman "o," upper-case roman "o," lower-case bold "o," and upper-case bold "o."

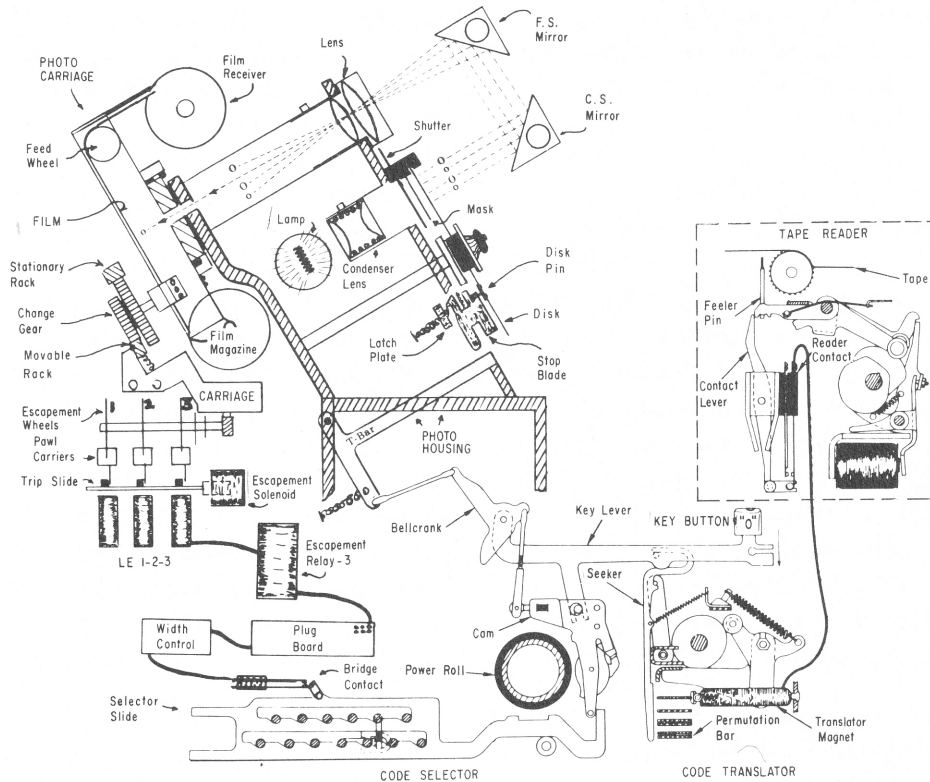


Figure 4-4. Mechanical Schematic, ATF B-8 Photographic Unit

Optical System

Two mirrors (labeled FS and CS in Figure 4-4) direct the light back through the lens toward the film and are automatically positioned to select the desired character from the four that have been illuminated. Each mirror can be rotated into one of two positions upon command of the input tape. The font shift (FS) mirror chooses between the two fonts; the case shift (CS) mirror chooses between shift and unshift characters. The combined effect of the two is to direct the light rays from the desired character into the lens so that only it will be passed through the entrance to the photo carriage and onto the film. In Figure 4-4 the lower-case bold "o" is the character that has been selected by the two mirrors to pass through the

aperture and onto the film; light rays from the other three characters are directed away from the entrance.

Tape Reader

The eight-level paper tape that controls this phototypesetter is read at two standard mechanical tape readers. It passes first through a rear reader, which passes it on to a front reader with its codes unread until a code giving a size for an interword space is sensed. This code is read at the rear reader and stored, after which the front reader processes the character and function codes that occur in the line whose interword space has just been stored.

Eight feeler pins (only one shown in Figure 4-4) press upward against the paper tape, and as the tape advances, one code at a time, those pins that are under code holes will be forced up through them, releasing the contact levers and closing the reader contacts. In the case of pins 1 through 6, which read the actual character codes, the resultant pattern of electric circuits acts through translator magnets and permutation bars to select the character key that is called for by the code. When a signal indicates that the phototypesetter is ready to set the characters, the key moves downward and its motion is transmitted through a standard electric-typewriter mechanism (key lever, cam, power roll, bell crank, and T-bar) to position the associated stop blade so that when the disk is released, the decoded character will be in projection position, as previously described.

Carriage Motion

In addition to being transmitted to a stop blade, the motion of the key is transmitted through the code selector to close a bridge contact. (Each character has its own associated bridge contact, just as it has its own stop blade.) This completes a circuit into the width control, which, in conjunction with the width control plugboard, gives out a current pattern that will activate a series of three escapement relays and two solenoids to move the photocarriage an amount equal to the set width of the character. The photocarriage, which carries the output film or paper, is activated by a shaft that is driven through a differential mechanism (stationary rack, change gear, and movable rack) by a carriage, which in turn is driven by three escapement wheels. These toothed escapement wheels are tripped by the escapement relays, acting through pawls. One wheel supplies enough motion to the movable rack to drive the photocarriage $1/6$ em; the second supplies enough motion to drive the carriage $1/3$ em; and the third supplies enough to drive the carriage $1/2$ em. Additional motions of $1/18$ and $2/18$ em can

be applied to the photocarriage by two solenoids that are not shown in the figure.

As a result of the motions induced by these relays and solenoids, the photocarriage, and therefore the output film or paper, is given a lateral motion equal to the set width of the character that has been decoded from the tape. The motions are additive. Plugboards and change gears must be changed when a type disk with different basic width assignments is installed.

Timing

The contact made by the disk pin and stop blade, in addition to stopping disk rotation when the desired character is in projection position, completes an electric circuit that energizes the timing-control circuitry. This causes the shutter to revolve, thereby exposing the character. In addition, it signals for the release of the key corresponding to the next character, which by this time has been read from the tape and decoded by the translator magnets. It also signals the tape reader to advance the tape one code, to read the next code, and to store it in the translator magnets until it is called for by the signal received when the character just read at the keyboard has been processed. Carriage motion to allow for set width follows the exposure of the character.

Function Codes

In addition to the character codes, whose processing has been described, the input tape contains function codes that provide essential typographical information (shift or unshift, for example). These function codes are not printed on the output but are identified by a hole in channel 8 of the tape. When this hole is sensed at the reader, a blind (not shown in Figure 4-4) near the photocarriage drops to prevent exposure of a character on the film. The code is then decoded in the width control and plug-board circuitry, and the output performs the desired functional command instead of processing a character. The shutter at the type disk rotates, just as it does when a character code is being processed; but because of the dropped blind, no character is exposed on the film. The electric signals to start processing the next character are produced in the usual fashion, and reading of the tape resumes.

Justification

The size of the justifying word space, which was decoded at the rear reader before the character codes for the line were processed at the front

reader, is stored in relays so that when a justifying space code is read at the front reader, the carriage can be moved the proper amount. This permits justification of the line. When a complete line has been composed, the film is advanced the interline space that has previously been introduced manually, the photocarriage is returned to the start-of-line position, a new value for the justifying word space is read from the tape and stored in the relays, and typesetting of the next line begins.

Tabulation

Tabulation is accomplished mechanically. Tab stops positioned manually along a tabulating rack located on the lower carriage. (Figure 4-1 shows part of this rack with one stop visible near the end.) When a tab code is sensed at the front reader, the carriage is released to move until its motion is arrested by the first stop it encounters, very much as the carriage of a standard typewriter is released to move to the next tab position when the tabulator key is pressed. Note that the tabulation information is not coded onto the tape, but must be furnished separately for use in positioning the tab stops.

Direct Keyboarding

Figure 4-4 also shows how direct keyboarding of the ATF Model B-8 photographic unit is accomplished. When the proper key is pressed, the key moves downward and actuates the same mechanism that is activated during tape-controlled operation. Characters are exposed and proper intercharacter distances are thus established. However, since no value for the justifying word space has been stored, the output will not be justified automatically. In effect, manual keyboarding can command the operations that are controlled from the front tape reader during automatic operation, but cannot provide the information extracted from the tape at the rear tape reader.

5. LOW-PRICED TEXT MACHINES

Some automatic photocomposers respond to the needs of diverse typesetting establishments, offering capabilities that, while not needed by all, are in sufficient demand to be included in a general-purpose machine. Other photocomposers specialize in one facet of the total typesetting task, sacrificing operating flexibility to simplified design. The latter machines are, of course, usually cheaper than the former, and sales success may be anticipated if there is sufficient demand for their chosen specialization.

Probably the most successful low-cost specialized machines have been introduced by the Compugraphic Corporation. In fact, their Series CG 2900 (described here) were among the first commercially successful automatic photocomposers. By concentrating on the typesetting of newspaper text, classified advertisements, and similar items that require infrequent changes in type size, type style, and line length, the designers produced machines that phototypeset galleys of newspaper columns at very low cost. Later additions to the Compugraphic line have widened its application by increasing its flexibility; but the original CG 2900 series remains a prime example of the success attendant upon intelligent specialization. An exterior view is shown in Figure 5-1.

COMPUGRAPHIC CG 2900 SERIES PHOTOTYPESETTERS

Characteristics of the CG 2961 and CG 2971

Two models, the CG 2961 and CG 2971, were originally offered by the Compugraphic Corporation. Both produce text composition in type sizes

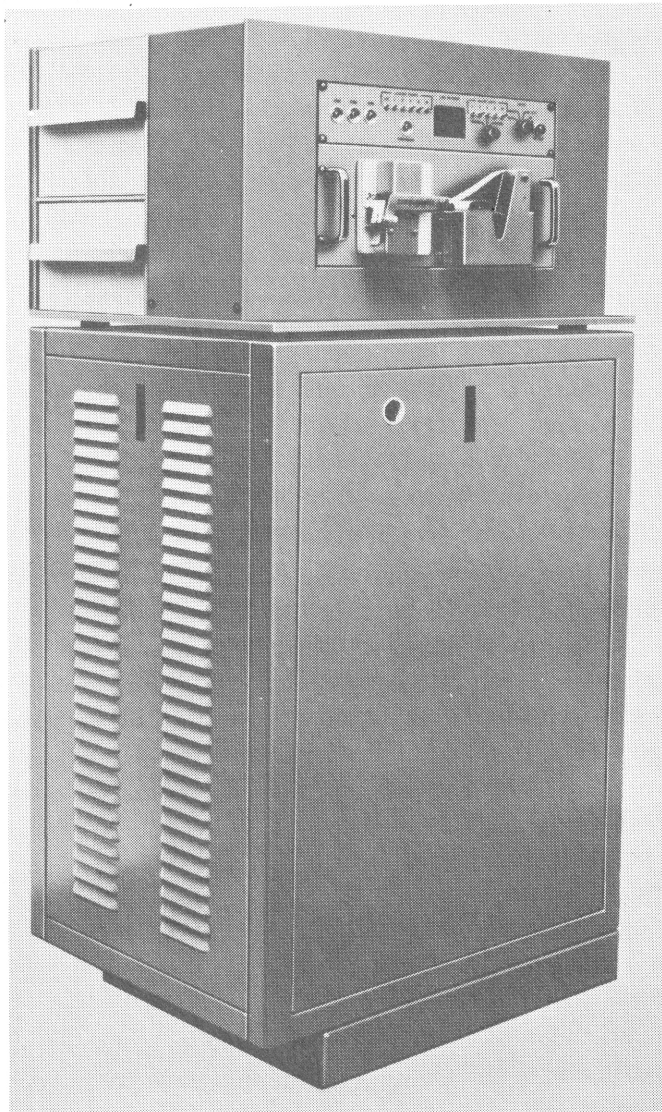


Figure 5-1. Exterior View, Compugraphic CG 2900 Series

ranging from 5 to 12 points, one point size at a time. Each includes a paper-tape reader to receive the input tape, control logic to perform the necessary typographic calculations (hyphenation and justification), and a photo-unit to produce the output on stabilization photographic paper. The entire phototypesetter stands on one base as shown in Fig. 5-1. The CG 2961 works from six-level input, and produces output in teletype unit-count faces only. Action of the CG 2971 is the same, except that it works from seven-level input.

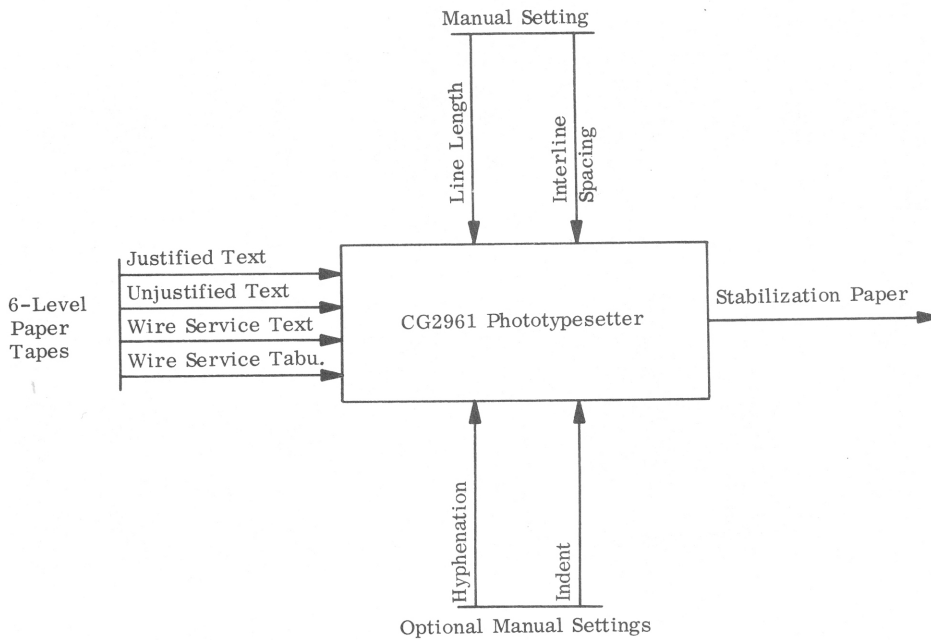


Figure 5-2. CG 2961 Phototypesetter System Configuration

System Configuration

Figure 5-2 illustrates the system configuration for the CG 2961 phototypesetter. Four different types of six-level paper tapes can be used as input. If the input consists of justified text, the tape must have been produced by a justifying keyboard. Wire Service Text and Wire Service Tabular refer to tape produced by newspaper wire services. This tape was originally designed to control tape-driven linecasters, and contains codes particularly directed toward that end.

The operator of the CG 2961 sets line length and interline spacing manually. He may also set a hanging indent or a second-line indent, and can choose whether or not the machine will hyphenate words to end lines. Output is typeset galleys produced on stabilization paper that can serve as a starting point for page makeup.

System configuration for the CG 2971 phototypesetter is the same as the configuration for the CG 2961 except that seven-level tape is used for input. This means that the Wire Service Text and Wire Service Tabular tapes cannot be handled. Tape for the CG 2971 is produced by a Friden Justewriter Recorder. (The CG 2971 was designed especially for owners of Justewriters who wished to use them as keyboards for the Compugraphic phototypesetter.)

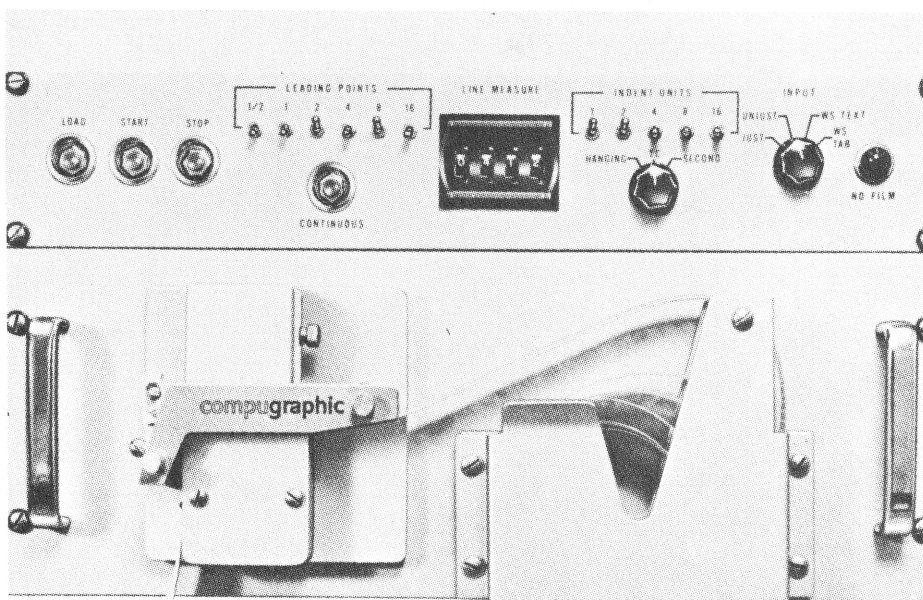


Figure 5-3. Main Control Panel and Tape Reader,
Compugraphic CG 2900 Series Phototypesetter

Mechanism Description

Machine Operation

Figure 5-1 shows a tape reader in the upper portion of the CG 2961 phototypesetter. This reader accepts paper tape, reading it photoelectrically at 125 codes per second. Above the reader, the main control panel can be seen, a closeup of which is presented as Figure 5-3. The data extracted from the tape are operated upon in the control logic to drive the photo-unit, which is housed in the upper cabinet. This unit contains a rotating font wheel that carries a font strip, which is a film strip with two 90-character duplexed fonts on it.

Images of the characters on the strip are projected onto photographic paper by a character-positioning lens in such a manner that they compose a line of copy on the paper. When a line of copy is finished, the paper is advanced the correct interline distance to place it in position for the next line. The photographic paper is a stabilization type. No darkroom is needed if the unprocessed paper is shielded from light.

Control Functions

Font codes and character codes from an input tape control the selection of characters by causing a lamp to flash when the desired character on a rotating wheel is in position to be projected onto the output. Char-

acter widths, obtained from the machine logic, control the placement of each character with respect to adjacent characters by imparting the proper motion to a lens that positions the characters along the line. Character widths together with line measure (manually introduced) and word-space data are used in the computation of the spacings that will cause the line to be justified.

Duplexed Fonts

Duplexed font pairs, which are used in the CG 2900 series phototypesetters, are two fonts in which corresponding characters have the same width. For example, if roman and bold fonts are duplexed, the roman "a" must have the same width as the bold "a," the roman "b" must have the same width as the bold "b," and so on. This restriction is widely accepted in newspaper textual composition, since it simplifies composition and transmission of copy for newspaper wire services. It would not be acceptable for work that employed very many type faces and larger point sizes.

Composing Capabilities

Point-size range is from 5 to 12 points, one size at a time. Line length can go as high as 33 picas. Line advance can be provided in ½-point increments.

Boldface paragraphs can be automatically produced by command of the input tape. Flush-left/flush-right copy (copy justified by inserting the needed additional white space at only one location in the line) or flush-left/center/flush-right (copy justified by inserting the needed white space at two locations in the line) can be automatically produced.

For unjustified input, three different types of automatic indentation can be provided. The output speed is 25 newspaper lines (8½ point, 11 pica) per minute.

Justified input is copy coded so that it is divided into justifiable lines. When the CG 2961 is operating with this type of input, its control logic determines the proper combination of interword and intercharacter spacing to justify the line. Unjustified copy is copy that is coded onto the tape with no division into lines. When the CG 2961 is operating with this type of input, its control logic automatically divides the text into justifiable lines by using the interword spaces, hyphens, and dashes of the copy as line-ending points or by hyphenating words through its hyphenation logic.

Unjustified copy can also be processed by the discretionary-hyphen system in which a tape-feed code is inserted by the keyboard operator at the normal division points within the words. The CG 2961 will ignore this code unless it falls at a useful line-ending point, in which case it will end

the line at that point and insert interword and intercharacter spacing to justify it.

The discretionary hyphen system provides for a more precise control of hyphenation than is possible with the hyphenation logic in the phototypesetter itself. For example, many publishers do not permit a line to be ended in the middle of a proper name, even though the break would divide the name correctly into syllables. Such a break might be produced by the hyphenation logic of the CG 2961, since it cannot distinguish between proper names and common nouns. If the copy includes many proper names, it can be keyboarded with a tape-feed code at the places where hyphenation would be permitted, and with no such codes in any of the proper names. The hyphenation logic of the machine is then made inactive by setting the hyphenation switch to "Off," with the result that the lines will end either at the natural word endings or at the places where the tape-feed codes have been punched. Proper names, therefore, will not be broken.

All type faces must be unit-count faces in the standard 282F Teletype arrangement. This means that the characters in one font must have the same character set widths as the corresponding characters in another font. (It does *not* mean that all characters in a single font must have the same set width.)

Functional Operations

Two types of input are used by the CG 2900 series phototypesetters. In general, data that are reasonably constant during the course of a job are entered manually by the operator. Data that change frequently are entered on the input tape. Assume that the CG 2900 phototypesetter is set to handle justified input. The input tape will carry code sequences for the characters that make up the words of the copy, and code sequences that call for certain functions. It will indicate where to break the copy to make it possible for the phototypesetter to set a justified line.

Character Coding

Codes for a complete line are read from the tape in the reader of the phototypesetter. Each of the character codes is associated with one of the 90 characters in the basic font on the wheel and with the character in the corresponding position of the duplexed font. Function codes will have indicated which of the two fonts is desired. As character codes are read from the tape, the xenon lamp will flash when the font wheel, which is constantly rotating, is so positioned that the designated character can be projected onto the output.

Widths associated with each of the characters will be furnished by the phototypesetter logic as the characters are read. This information is applied through a pair of set-width gears to move the lens carriage the lateral amounts that will lay down the characters at their proper positions along the output line. The same widths are subtracted from the line measure (a manually introduced quantity that furnishes line length in units that can be used by the machine).

When an interword-space code is read from the tape, a nominal value for it is subtracted from the line measure. When the code that indicates end of line is read, the amount of the line that is left, which will be the amount of the line that has not been occupied by characters and interword spaces, will be divided among the interword and intercharacter spaces to justify the line. If unjustified input is being processed, the end-of-line positions are computed by the machine logic instead of being read from the input tape.

Optical System

Figure 5-4 shows the optical system schematically. A font wheel carrying the film strip rotates at 25 revolutions per minute. Characters from two 90-character duplexed fonts appear along one edge of the film. Along the other edge is a series of marks that are used as part of a stroboscopic selection system to flash a xenon lamp (inside the font wheel, and therefore hidden in the figure) when the desired character is in projection position. The character is projected by a lens onto the output, which is stabilization paper.

In addition to imaging the character on the output, the lens is moved laterally across the output to locate the character properly along the typeset line. For example, when the lens is in the position indicated by the solid lines in Figure 5-4, the character will be located at 1; but when it is in the position indicated by the broken lines, the character will be located at 2.

Proper placement of the characters demands that the lens move enough between flashes to allow for the set widths of the characters being typeset. A character is flashed, the lens is moved to allow for its set width, the next character is flashed, the lens is moved again to allow for its set width, and so on until the entire line has been typeset. Then the output paper is advanced to position it properly to receive the next line, the lens is returned to the start-of-line position, and typesetting of another line commences.

Logic circuitry to provide the basic character set widths is built into these phototypesetters. Since all the type fonts they handle have the standard 282F Teletype width assignments, one batch of basic set widths is

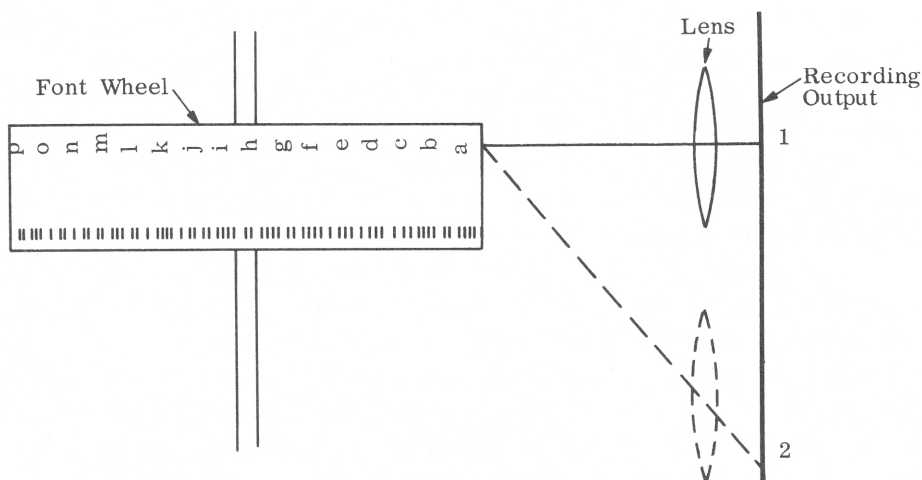


Figure 5-4. Optical Schematic, Compugraphic CG 2900 Series Phototypesetter

sufficient for all type fonts, and one set of logic circuits can supply the basic widths for all type styles. However, when type size is changed, an alteration in the character set widths must be made, since the width of a character will increase as its height increases. Allowance for such a change is made by changing the gears that drive the lens. A set of these gears (called set-width gears) is supplied for each point size, and they are designed to drive the lens a greater distance for a character in a large point size than for the same character in a smaller point size.

Magnification of the optical system cannot be varied; therefore, it is necessary to change film strips when point size is changed. The lens is stationary while the character is being flashed.

6. OPTICAL CHARACTER GENERATORS—ROTATING FONT

Of all the methods for producing typographic characters photographically, optical generation from rotating fonts is the most popular for galley-producing machines. This system, pioneered by Photon, has proved efficient for all applications except those that require computer-compatible speeds, where electronic methods find increased application. The number of manufacturers using the method is a demonstration of its soundness.

In the original Photon photocomposers, the master characters were carried on a disk that rotated in front of a xenon flash lamp; when the proper character was in projection position, the lamp flashed to expose it onto photographic material. In the more recent 713 Series, film segments replace the glass disk. This series is described in this chapter as (1) an example of an effective optical photocomposer and (2) an indication of how an extensive product line of machines can be obtained from the same basic optical system.

PHOTON 713 SERIES PHOTOTYPESETTERS

Characteristics of the 713 Series

The Photon 713 Series is a group of phototypesetters that employs optical methods of character generation and display to produce typeset galleys on phototypesetting film or paper. Character fonts are on a continuously rotating drum. When the desired character is in position, a high-intensity lamp flashes so that the character will be imaged on the output

material by an optical system. Characters are laid down at speeds that vary with model and point size. Character selection, type size, type style, and other typographical characteristics are under complete control of the input paper or magnetic tape, unless the operator overrides the automatic control by introducing parameters manually.

System Configuration

The basic phototypesetter consists of two units, the photo-unit and the control console, each housed in a separate cabinet (Figure 6-1). Figure 6-2 exhibits the system configuration for the Photon 713-10 and 713-100. The lighttight cabinet for the photo-unit contains the components for producing justified lines of copy under control of the logic section in the control console.

Before composition can begin, the control console must be loaded with memory tables, via eight-level paper tapes with each set of fonts. These tables provide the control logic with needed information about the particular combination of type styles that is being used. Input is obtained

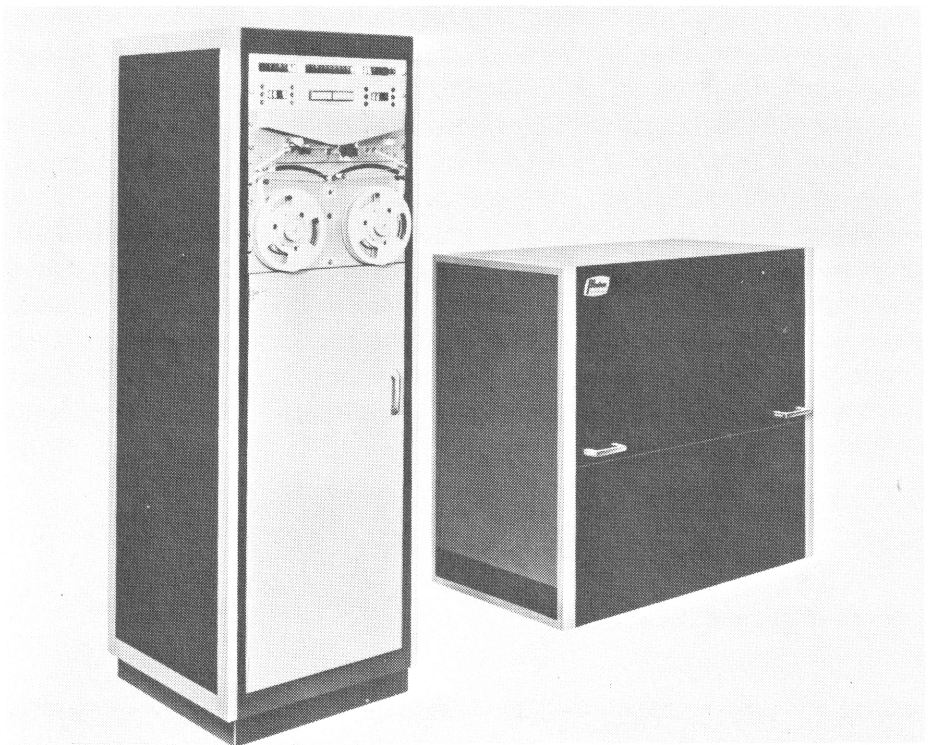


Figure 6-1. System Photograph, Photon 713-10

from six-, seven-, or eight-level paper tape containing justified copy in coded form, or from similarly coded magnetic tape if the optional magnetic tape reader is available.

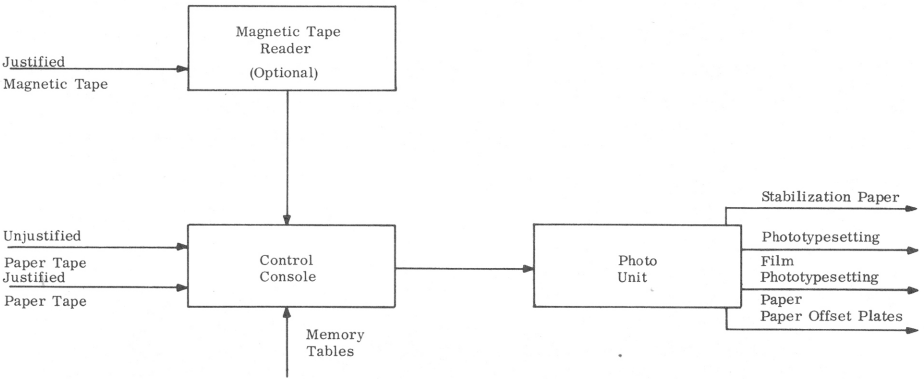


Figure 6-2. System Configuration, Photon 713-10 and 713-100

Output consists of typeset matter on phototypesetting film, phototypesetting paper, or stabilization paper; some suppliers furnish direct-process paper offset plates as well. Usually, output is removed from the photo-unit for processing; however, a device to feed exposed stabilization paper directly into a processor is available.

Figure 6-3 shows the system configuration for the Photon 713-20 and 713-200. Note that either unjustified or justified tape may serve as input. (Justified tape carries coded copy that has been divided into justifiable lines; unjustified tape carries copy that has not been divided into lines.)

The 713-100 differs from the 713-10 in that each character on a font strip is repeated in a different portion of the strip. This repetition cuts the character capacity from 64 to 32, but increases composition speed. The same difference distinguishes the 713-200 from the 713-20. The usual maxi-

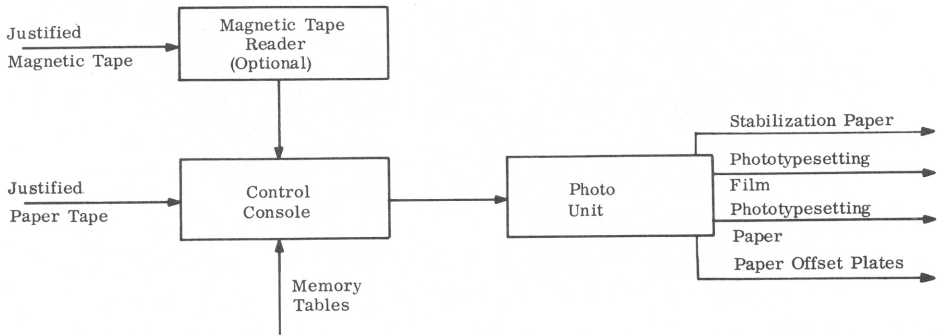


Figure 6-3. System Configuration, Photon 713-20 and 713-200

imum line length for the 713-10 and 713-20 is 45 picas, which can be increased to 90 picas by a special adapter. The maximum line length for all 713-100 and 713-200 Photons is 90 picas.

The 713 Series also includes the 713-5 (Figure 6-4), a single-unit machine in which much of the control logic as well as the memory tables are supplied via programming tapes. For example, automatic hyphenless justification and tabulation can be performed by the machine if the proper programming tapes are loaded into its memory before typesetting starts. Four different models are offered: (1) the standard model, producing only two different point sizes up to an 18-point maximum; (2) the Taskmaster I

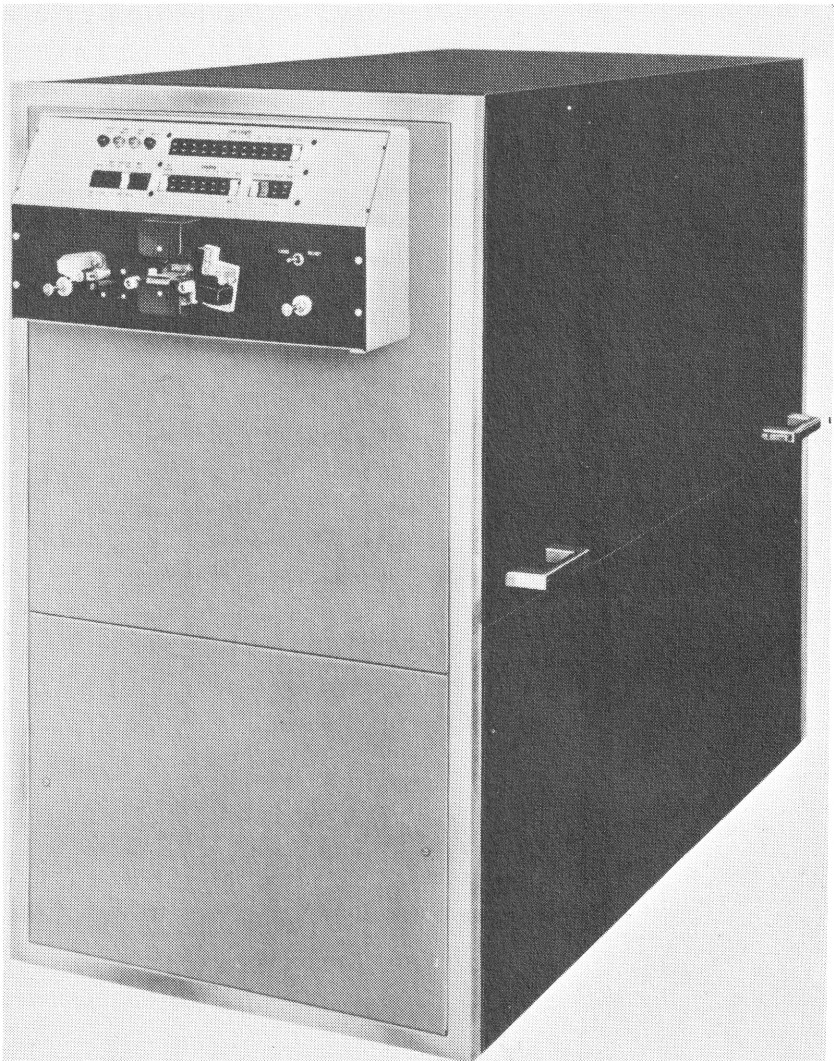


Figure 6-4. Photon 713-5 Phototypesetter

model, which can automatically produce eight different point sizes up to a 36-point maximum; (3) the Taskmaster II model, which can produce 16 point sizes up to a 72-point maximum; and (4) the Combo model, which can produce 24 point sizes up to a 144-point maximum on a strip of film or paper.

Photon has also offered the Headmaster, a 713-10 modified so that it can produce 16 point sizes up to a 72-point maximum. (The standard 713-10 produces eight point sizes up to a 36-point maximum.)

Mechanism Description

With the exception of the 713-5, 713-5 Taskmasters, and 713-5 Combo, members of the Photon 713 Series are two-unit phototypesetters. The control console, shown to the left in Figure 6-1, contains a tape reader to read input tape and logic circuitry to process the read data. The photo-unit operates under the direction of the control console to produce typeset copy on photographic film or paper. Electric cables connect the two units.

Font characters, carried on a rotating drum, are projected onto photographic film (or paper) by a variable-power optical system, which provides for automatic variation in point size as directed by the input tape. The character called for by the input tape is illuminated by a flash from a xenon lamp when the rotating drum has carried it to the proper position for projection onto the output.

Projected characters are reflected onto the output by a mirror that moves intermittently across the width of the output. The mirror remains stationary while several characters are composed, character positioning along the line being accomplished by small automatic adjustments in the position of the rotating drum when the character is flashed. Then the mirror is moved a small amount along the line of output to a new position, at which point the next few characters are flashed and positioned by adjustments in the drum position; the mirror is moved again, and so on. By thus dividing the positioning task between mirror and drum, system speed is higher than it would be if the total task were performed by the mirror, which would have to be moved to a new position for each character.

Composing Capabilities

Photo-units of the 713-10 and 713-20 phototypesetters accommodate eight different typefaces, each containing 96 characters. Since the photo-units of the 713-100 and 713-200 repeat the fonts, they can output only four different typefaces, but because the fonts are repeated, the drum carrying them does not have to rotate as far between characters and so output speed increases substantially. However, the 713-100 can operate in the

same mode as the 713-10 and carry the full complement of eight different 96-character faces. Its speed will then be reduced to about 60 characters per second.

Each of the characters on the font strips can be reproduced in eight different point sizes. Size changes are made automatically by a turret that rotates lenses of different magnification into the optical system; the customer chooses eight lenses that will produce the point sizes (minimum 5, maximum 36) he desires. Lenses, once installed, are not ordinarily replaced, since much changes must be made by service personnel.

In the Headmaster model, an extra 2X lens, not on the turret, can be swung into the optical system to double the size of the output characters. This doubles the number of available point sizes and increases the maximum point size to 72.

The standard 713-5 carries only two lenses, and therefore can produce only two different point sizes. The other models of the 713-5 Series have the regular eight-lens turret. Taskmaster II incorporates the extra 2X lens, giving it the same character capacity as the 713-10 Headmaster. In the 713-5 Combo, both 2X and 4X lenses can swing, one at a time, into the optical system, and thus increase capacity even more.

Functional Operations

Since the same operating principles govern the entire Photon 713 Series, the methodology presented here for the two-unit machines applies directly to the 713-5 if note is taken of its single-unit construction, the reduced lens capacity of its standard model, and the fact that control logic as well as memory tables are programmed into it.

Table 6-1 lists the principal inputs to the control console and their main effects upon the operation of the photo-unit. Although a tabulation of this sort cannot exhibit all interactions of the different inputs, it does

Table 6-1. Inputs to the Photon 713 Series and Their Effects

INPUTS TO CONTROL CONSOLE	PRINCIPAL EFFECTS ON PHOTO UNIT OPERATION
Typeface	Selects lamp to be flashed; positions vertical aperture
Character	Selects time of flash in conjunction with other inputs
Character width	Positions mirror; positions horizontal aperture; selects time of flash in conjunction with other inputs
Point size	Selects lens from turret; in some models also selects an additional lens
Line length	Used to compute justification spacing and to trigger end-of-line sequence
Interline spacing	Sets amount of film advance

facilitate understanding of overall function. Except for character widths, all inputs in Table 6-1 come from the input tape.

Coding

Typeface codes on a tape specify the font in which the characters following them will be set. In the photo-unit, this function involves selecting one of the two xenon lamps to be flashed (in effect, choosing between the top four rows or the bottom four rows on the font drum) and positioning the horizontal slit aperture (which chooses the proper row of the chosen four).

Character codes and character width codes control the timing of the flash that illuminates the desired character on the rotating drum; when the character is in position to be projected onto the output, the lamp flashes. Character-width codes also control the position of another aperture that intercepts the light from neighboring characters on the drum, which might otherwise be projected. They also control the position of the mirror that helps locate the characters properly on the output.

Point-size codes select the lens that will magnify the font character to the desired output size. The lenses are carried on a turret. Interline spacing sets the amount of film (or paper) advance between lines. Line length is used in the computation of justification spacing.

The Photo-Unit Optical System

Actual selection, sizing, and placement of the characters are accomplished in the photo-unit, which operates under the control of signals from the control console. Fonts of characters are carried on a rotating drum in the form of negative images on strips of 35-mm film. From the characters on this drum the photo-unit must select the one that corresponds to the input code, illuminate it for projection onto the output, magnify it to the size specified by the input code, and position it on the output so that it will be located correctly along the typeset line. The photo-unit must also effect the proper separation between lines.

Characters for selection and flashing are obtained from 12 film segments carried on a rotating drum. These segments are arranged on the drum in two sets, an upper six-segment set and a lower six-segment set. A segment, in turn, comprises four rows of 16 characters each. Thus, the rotating drum carries eight rows of 96 characters, or a total of 768. The drum assembly is shown in Figure 6-5.

Inside the drum assembly are two xenon stroboscopic lamps, one to illuminate the top set of six segments and the other to illuminate the bottom set. The drum, turning at 30 rotations per second, carries the char-

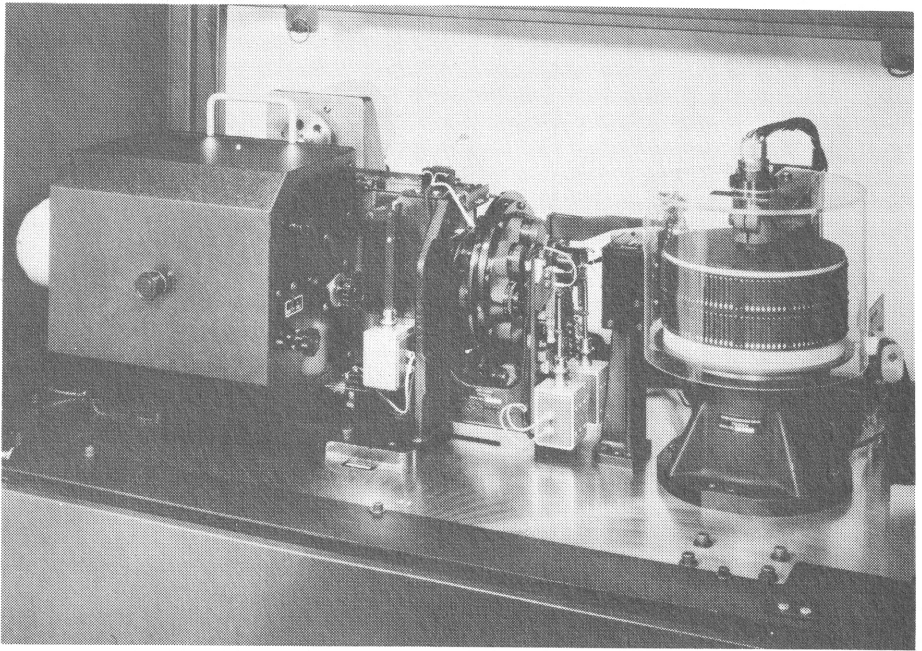


Figure 6-5. Internal Mechanism, Photo-unit, Photon 713-10

acters in and out of the aperture of the optical system (Figure 6-6). When the desired character is in position to be projected onto the output, the proper lamp flashes to illuminate it.

Although the inclusion of two lamps permits the top and bottom set of film segments to be illuminated separately, it does not by itself restrict illumination to the desired character. That restriction is accomplished with two movable apertures, one vertical and one horizontal. The vertical aperture has two *horizontal* slits, the bottom one exposing a group of adjacent characters in one row of the bottom set of film segments, and the top one exposing the corresponding group of characters in one row of the top set of segments. This aperture is automatically moved up and down to expose the level of the drum that contains the desired character; when the proper lamp flashes, light is passed by the correct character, but if it were not for the interception of the horizontal aperture, several adjacent characters would also be projected. The horizontal aperture contains a *vertical* slit just wide enough to permit passage of light from a single character and thus blocks out light of adjacent characters. In this way the intersection of the vertical slit in the horizontal aperture and the horizontal slit in the vertical aperture allow projection of only one character.

If the characters were always flashed when they were passing the same point in the optical system, it would not be necessary to use two apertures;

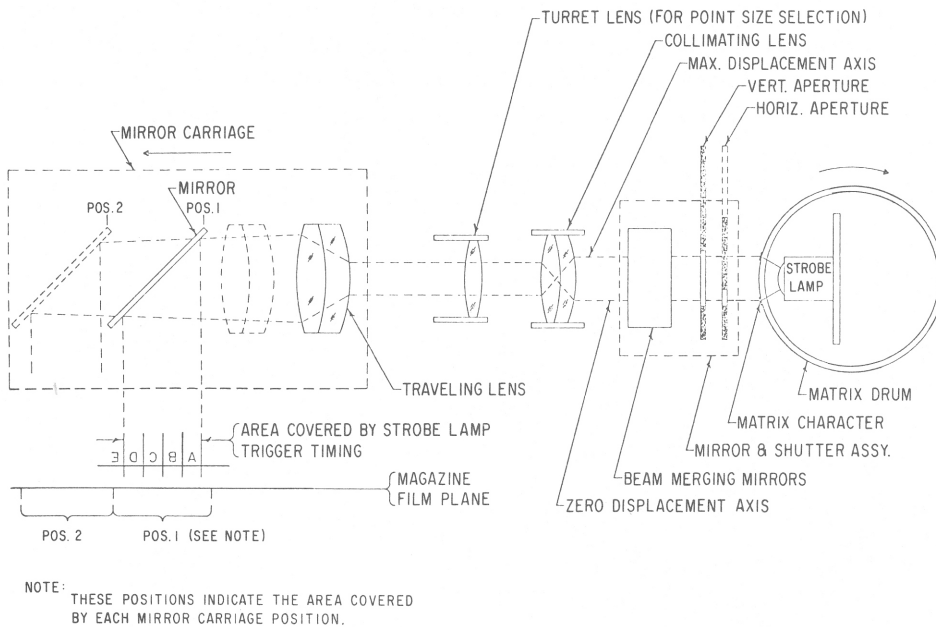


Figure 6-6. Optical System, Photon 713-10

a simple vertically moving single-character window would be sufficient. As explained later, two apertures allow characters to be flashed at different points in their rotation.

Projection, magnification, and placement of the flashed character are accomplished by the optical system shown schematically in Figure 6-6. The strobe lamp, font drum, horizontal aperture, and vertical aperture were discussed in the preceding paragraphs. Other components and their functions are:

1. *Beam merging mirrors* unite the optical axis from the top set of segments with that from the bottom set to ensure that all characters in a line of output will be aligned, regardless of whether they are extracted from the top or bottom set of segments.
2. A *collimating lens* moves with the vertical aperture to ensure that characters from different rows of a segment will be laid down on the same line of output.
3. A *turret lens* provides the proper magnification for the desired point size. Eight lenses can be carried in the turret; the correct one for the desired point size is rotated into position upon command from the control console.
4. A *traveling lens* images the character on the output in the size set by the turret lens.

5. A *traveling mirror* moves across the width of the output so that the bundle of light forming the image of the character is moved along the line, thus moving the position occupied by the character on the line. (The traveling lens also moves on the same carriage.)

To ensure sharpness, the mirror is held motionless during the actual flashing of a character. If the mirror alone did the positioning, composition speed would suffer because the mirror would have to be started, moved, and stopped between the flashing of each two characters. Such a time-consuming procedure is obviated by moving the mirror less frequently and varying the character flash position to output characters properly while the mirror is motionless. Hence, the mirror need be moved only after several characters have been composed.

Figure 6-6 shows this arrangement schematically. With the mirror in position 1, the sequence *ABCD* is laid down along the line of output by varying flash position from the zero displacement axis (for *A*) to the maximum displacement axis (for *D*); then the mirror is moved to position 2. The next character (in this case *E*) will be fired near the zero-displacement axis, and so on for the entire line. The number of characters produced at each mirror position and the precise location of flash positions will depend on point size, character width, and intercharacter spacing, each of which is directed from the control console in such a manner that all characters are properly positioned along the line of output copy. Large characters (24 point and greater) are flashed twice to maintain satisfactory blackness in the output.

When a complete line of copy has been composed, the mirror carriage returns to its start-of-line position, the output film or paper advances the correct interline distance, and composition of the next line begins. The entire job is produced in this manner.

The Control Console

The control console contains a memory section in which character widths and character locations on the font drum of the photo-unit are stored. As the characters are processed, their widths are extracted from memory and subtracted from the desired line length (normally read from the input tape, although it may be entered manually). A nominal value is subtracted from each interword space, and when the end-of-line is processed (or when the console logic has determined that the line should be ended, in the case of unjustified copy), the amount of spacing remaining in the line is divided by the number of interword spaces, to obtain the additional interword spacing needed for justification. (When unjustified input is being processed, space is also added between characters). The char-

acters, their widths, and the space values are held in the memory of the control console until the justification spacings have been computed, and then are supplied to the photo-unit. Quadded and centered lines can be similarly obtained.

Locations of characters on the rotating drum and their widths are introduced into the memory of the control console from specially prepared eight-level memory tapes. These tapes tell the control console what character should be flashed to correspond to each input code, and what its width should be. The control console may be adapted to read any six-, seven-, or eight-level code by means of these tapes.

Two types of memory table tapes are used: position table tapes and width table tapes. The position table tapes contain the character codes in a specified order. Each character position on the tape is associated with a character position on the revolving font drum. When the tape is loaded into the memory of the control console, the character codes from the tape positions are assigned to control the corresponding drum positions. For example, the code in position 3 of the tape is always assigned to control position 45 on the drum; hence, the character in position 45 will be selected for typesetting whenever that code is read from the input tape. In this fashion, it is possible to assign any output character to any input code. One position table tape is needed for each different input-coding scheme.

The width table tapes (four for each drum) contain set widths for each of the font characters. The widths on the width table tape occupy the same locations as the corresponding characters on the position table tape. When this tape is loaded into the control console, each width is assigned to the corresponding character. Some of the operator controls are used to assign the widths to the proper type font. Other positions on these tapes are used to assign function codes.

In the basic 713 Series Photons, fonts are introduced as duplexed pairs; that is, corresponding characters in the two fonts must have the same widths. This restriction is the same as that imposed when characters from two fonts are placed on the same linotype matrix in the conventional duplex system. Since the duplex system has been used successfully in hot-metal composition for many decades, it should be acceptable in comparable phototypesetting applications. For those applications in which the width restriction inherent in duplexing is not acceptable, Photon markets an expanded memory that gives the control console the necessary memory to provide distinctive widths for each character.

Line length, interline spacing, point size, and typeface are normally read from the input tape, although they can be entered into the control console manually.

7. OPTICAL CHARACTER GENERATORS—STATIONARY FONT

Optical photocomposers using stationary fonts were developed concurrently with those using rotating fonts, and were introduced shortly after them. Their advocates claim to obtain sharper output characters with them; their detractors object to the relative complexity of the character-selection mechanisms that they use. This is the kind of dispute that is never entirely resolved. Nevertheless, both types of photocomposers compete actively in the marketplace.

LINOFILM SUPER-QUICK OPTICAL COMPOSER

As an example of photocomposers that generate characters optically from a stationary font, consider the Linofilm Super-Quick Machine, a device manufactured by the Mergenthaler Linotype Company (Figure 7-1).

System Configuration

Characters for the wide-range version are projected from four optical grids, each of which contains two 96-character fonts. Codes read off the input tape, or a signal introduced at a manual control switch causes the desired grid to swing into a position where it can be illuminated by a xenon projection lamp.

Selection of the character is made by eight optical wedges, four of which deflect the optical axis up and down, and four of which deflect it left and right. Each character on the grid has a unique combination of

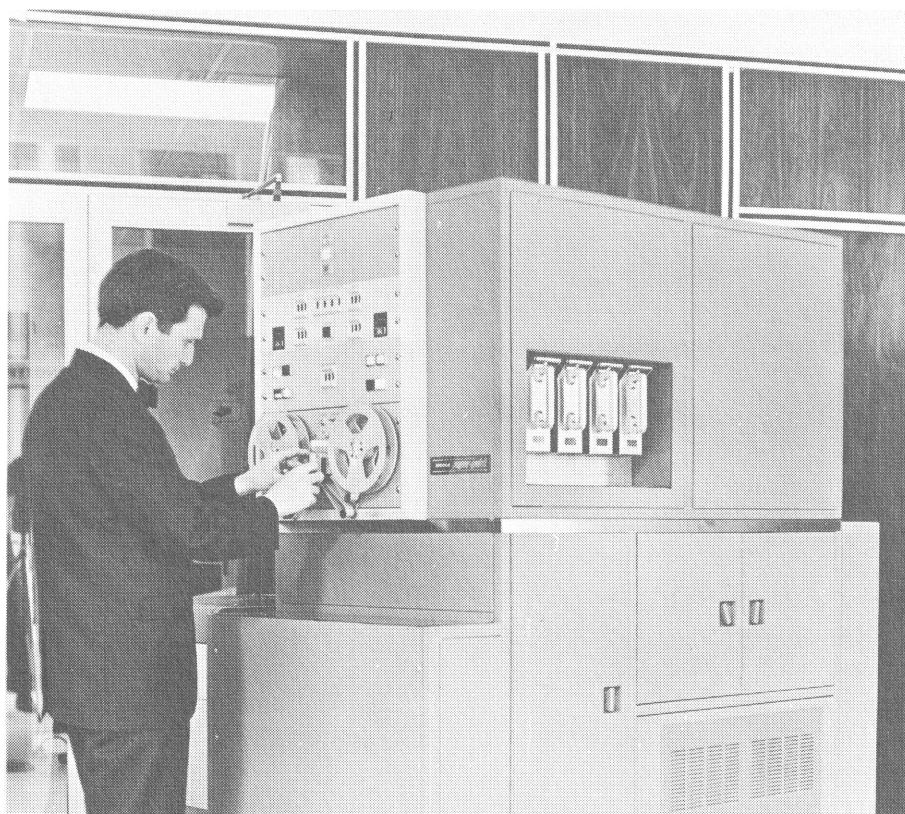


Figure 7-1. Exterior View, Linofilm Super-Quick Machine

wedge positions that will cause it to be picked up by the optical system of the machine and projected onto the output film or paper.

A turret containing several lenses can be rotated, either manually or automatically under tape control, to vary type size; a pair of blades driven by a stepping motor serves as a shutter; and a traveling-mirror system bends the optical axis 90 degrees and steps it across the output film so that each character will be properly positioned in the line of output copy.

Figure 7-2 diagrams the inputs and outputs. Input is furnished by six-level paper tape, coded according to either the standard wire-service format or according to a mixing format, the principal use of the latter being when more than one character grid must be automatically called for by the tape.

Wire-service format is that used in standard teletypesetter composition. It obtains its name from its use by newspaper wire services in the transmission of text over land lines.

Output is produced on phototypesetting film, or phototypesetting paper, or stabilization paper; in this respect, the Super-Quick is similar to a number of other phototypesetting machines. This output, which must be removed from the machine for processing, can be used as a starting point for the making of printing plates.

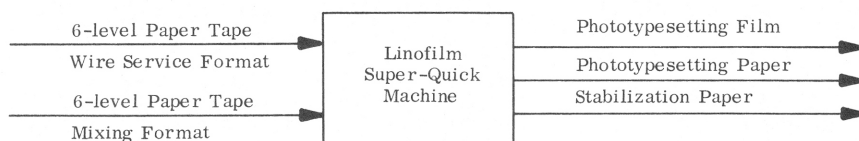


Figure 7-2. System Configuration, Linofilm Super-Quick Machine

The TTS (teletypesetter) coded, six-level paper tape that controls the Super-Quick is the same tape that controls hot-metal linecasters and a number of photocomposers, and can be produced by a number of different keyboards. Mergenthaler itself offers the Linoquick perforator. In addition, it is possible to produce the tape at a computer that operates on the product of a less-specialized keyboard.

Mergenthaler has marketed three models of the Linofilm Super-Quick Machine, which, although basically the same in construction and operation, differ slightly in typesetting capability. The lowest-priced model was the two-grid standard Super-Quick, which accommodated two character grids and had a typesetting range of 5 to 18 points. The four-grid standard Super-Quick has the same typesetting range, but, as the name implies, it can handle four character grids. The wide-range Super-Quick Machine can handle four character grids and has a typesetting range of 5 to 72 points. This chapter has been organized around the wide-range model.

Three options may be ordered to extend the capability of the Super-Quick Machine. A Tabmatic option enables the machine to compose tabular matter automatically; an Automeasure option enables it to obtain line length directly from the tape; and a Tape Film Advance option enables it to obtain film-advance information directly from the tape. Any combination of these three options can be housed in the option cabinet (Figure 7-3, which shows all three options installed).

Besides the options, the Super-Quick Machine may be equipped with accessories for automatic quadding and the production of wrong-reading output. The first of these is a set of printed-circuit cards wired into the machine to permit it to recognize quadding codes on the input tape and to perform the quadding functions called for by them. The second is a specially designed prism, which can be installed in the optical system in about 10 minutes.



Figure 7-3. Option Cabinet for Linofilm Super-Quick Machine

Mechanism Description

In the Super-Quick, as in all optical phototypesetters, characters needed for the typesetting process are obtained from small negative images (white type on black backgrounds), which can be automatically selected and projected onto the output in proper position to compose a

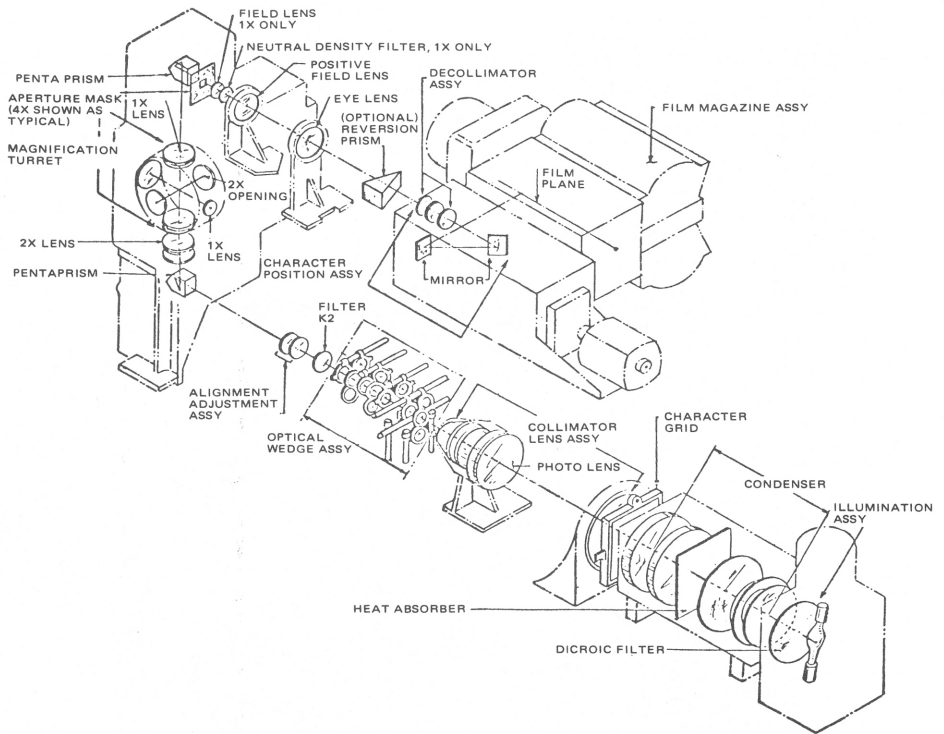


Figure 7-4. Optical Schematic, Linofilm Super-Quick Machine

typeset line. These negative images are carried in four 8x8 arrays on 6-inch square glass plates, which are called character grids (Figure 7-5). Two of these arrays are used for each font; however, since coding considerations limit the number of characters per font to 96, not all possible locations in the array will be occupied by characters. Four grids (only one shown in Figure 7-4) are carried in the machine at one time, mounted on the arms of a cruciform member that can rotate to place any one of them in position for typesetting. The grids remain stationary throughout the typesetting process except when they are being rotated to change the grid that is in position.

The positioned grid is illuminated by a xenon arc lamp mounted on an adjustable holder in a metal box, called an illumination assembly in Figure 7-4. Light from the lamp is distributed evenly over the character grid by condenser lenses specifically designed for this purpose. After passing through the character grid, the light enters a collimator assembly, which is a series of lenses that bend the light so that all rays entering it from any one point on the grid emerge as a beam of parallel rays. This is demonstrated in Figure 7-6, where the diverging light rays from several different

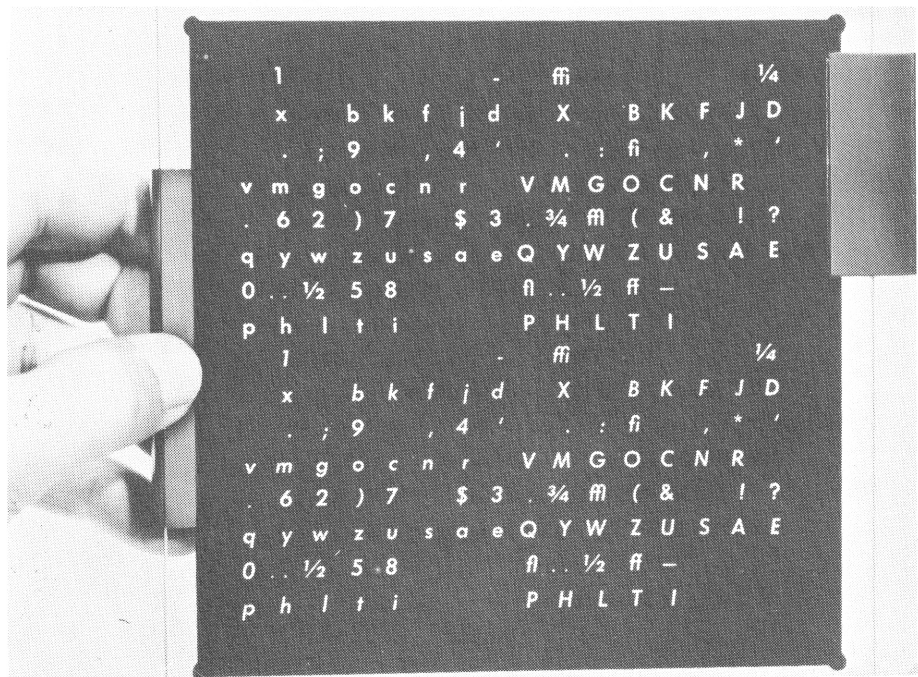


Figure 7-5. Character Grid for Linofilm Super-Quick Machine

points on the grid are shown converted by the collimator lens assembly into bundles of parallel rays before they enter the wedges.

The wedges shown schematically in Figure 7-6 are part of an optical wedge assembly, which consists of eight pairs of wedges that select the desired character from the grid in response to codes on the input tape. Each of the pairs contains a positive and a negative component (shown on Figure 7-4 as two circular components attached to a single drive rod). Four of the pairs will bend the light up or down by fixed amounts, which depend upon the refractive angles of the wedges; the other four will bend the light left or right. The refractive angles of the wedges have been chosen so that there is (for each character position on the grid) a unique combination of wedge positions that will bend the light the amount needed to send it down the optical axis to other components of the system.

Wedge Principles

Figure 7-6 will help clarify the basic principles of wedge action. Line A shows light emerging from a point on the lower edge of the grid, being

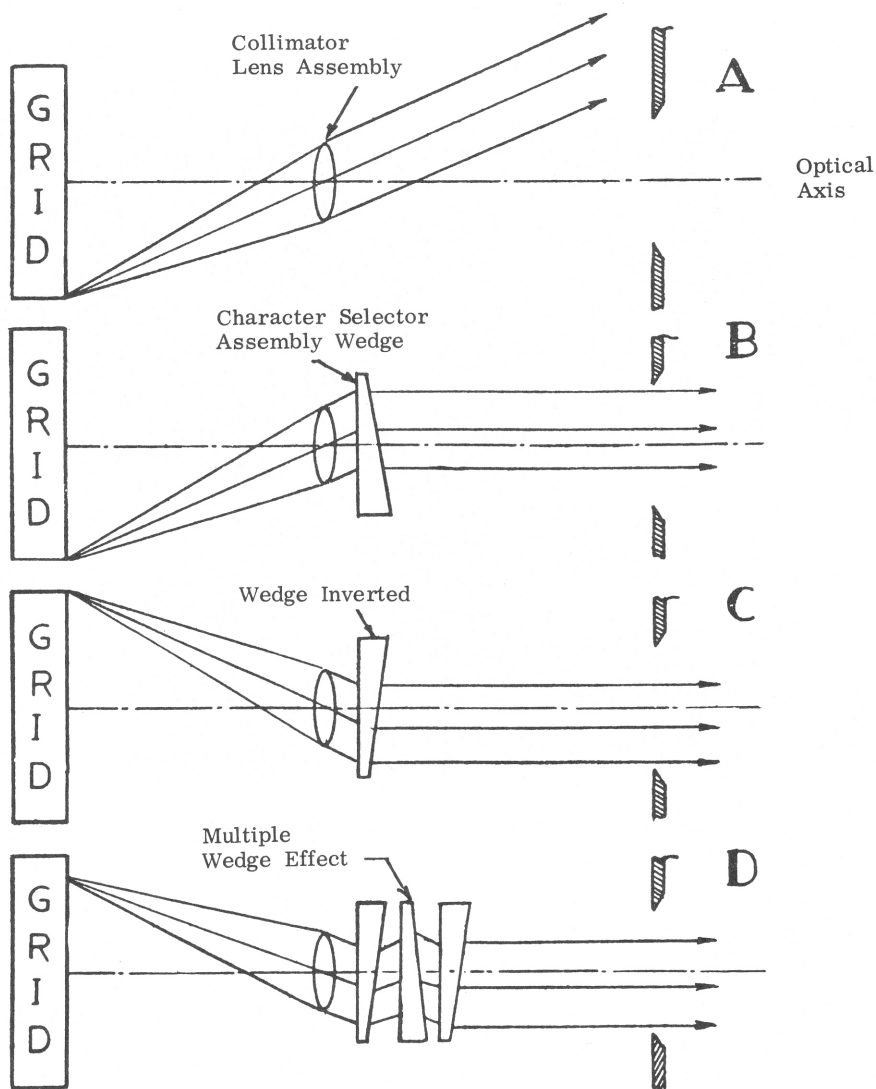


Figure 7-6. Schematic of Wedge Action, Linofilm Super-Quick Machine

collimated at the collimator lens assembly, and then continuing its travel up and away from the optical axis so that none of it passes on to the rest of the optical system. Line B shows how a single wedge of the proper refractive angle can bend the collimated light so that it passes along the optical axis to the rest of the system for projection onto the output. Line C shows how an inverted wedge of the same refractive angle would place a spot located at the upper edge of the grid on the optical axis. Line D shows the multiple-wedge effect, how with one erect and two inverted wedges the light from a spot located a definite distance below the top edge would be collimated and bent so that it was parallel to the optical axis and in position to be projected onto the output.

In all these cases, it should be added that although the rays from only one point on the grid will emerge from the wedges parallel to the optical axis, rays from nearby points will emerge in bundles of parallel rays that make only small angles with the axis, and that the aperture of the optical system (represented in Figure 7-6 by a break in the crosshatched barrier) is large enough to allow enough of those nearby rays to enter the system and project a complete character onto the output.

Wedge Action

In the actual machine, all light that is actually projected onto the output is refracted by one wedge from each of the eight wedge pairs. Each of the four vertical wedge pairs is set to bend the light up or down, and each of the four horizontal wedge pairs is set to bend the light left or right, by sliding it until the desired wedge of the pair is set in the optical path. This sliding motion is automatically controlled by the signals that are read from the input tape.

A “shift” or an “unshift” code first selects the wedge of pair 8 that will direct the scan toward the left or right half of the grid. (Shift characters occupy the left half; unshift characters, the right half.) A “lower rail” or an “upper rail” code then selects the wedge of pair 7 that will direct the scan toward the bottom or the top half of the grid. (Lower-rail characters occupy the bottom half; upper-rail characters, the top half.) The remaining six wedges are positioned in accordance with the character codes to bring the desired character into the optical path.

Alignment Adjustment

An alignment adjustment assembly, consisting of a pair of thin lenses and a mechanical drive, has been placed in the optical system after the wedges. By giving one lens of the pair a slight lateral motion with respect to the other, the optical axis and hence the ultimate location of the character on the output can be shifted a little bit. As the individual characters are selected in response to the codes from the input tape, the lenses are automatically shifted enough to compensate for the fact that no two sets of wedges have exactly the same refractive characteristics, even though they are made to the same specifications. In addition, the lenses are used to make possible a final increment of character placement along a line of output. (With the adjustment assembly, a character can be located along the line to the nearest $1/8$ point, even though the minimum increment of output motion is $1/4$ point. This is accomplished by positioning the carriage to within $1/4$ point and then adding an extra $1/8$ point, if

needed, by moving the image with the adjustment assembly. The operation is, of course, completely automatic.)

Magnification

Two pentaprisms fold the optical axis 180 degrees so that the overall length of the machine will not be excessive. In the vertical portion between the prisms is located a stationary 2X lens and a rotatable magnification turret. If the turret is set so that only the 2X lens is on the optical axis (accomplished by rotating it until the 2X openings in it are on the axis), the character set on the output material will be twice the size of the master character on the character grid. If the turret is set so that its pair of 1X lenses is on the optical axis, which is the position actually shown in Figure 7-4, the output character will have the same size that it has on the character grid. If the turret is rotated so that the 4X pair of lenses is on the axis, the output character will be reproduced at four times the size of the character on the grid.

Note that the 2X lens is always in the optical path, regardless of the magnification. An aperture mask is coupled to the drive mechanism of the magnification turret to place a square opening, properly sized for the magnification, in the system. Its function is to eliminate unwanted light rays from the system. For 1X magnification, a neutral density filter is also automatically inserted to reduce the light intensity, which will be greater at the smaller magnification and could cause overexposure of the output at that size. An extra lens, called the 1X field lens on Figure 7-4, also is swung into the optical system at 1X magnification.

Image Formation

Other lenses pass the collimated light down to a decollimator assembly, which causes the bundles of parallel rays to converge into points to form an image of the selected character. The decollimator assembly is mounted on a movable carriage along with a pair of mirrors that reflect the light 90 degrees. The lenses of the decollimator assembly form the image of the character, the mirrors reflect the light so that the image is formed at the film plane, and a motion of the lens and mirror system along the longitudinal axis of the system makes possible the placement of the character image at any point along a line of output copy.

Proper placement is accomplished by exposing each character when the lead screw has moved the lens and mirror system an amount equal to the character set width. A roll of unexposed film or paper is carried in a magazine; and every time a line has been typeset, the output material is

advanced the desired interline distance before typesetting of the next line starts, which places the lines properly on the output galley.

Shutter

Figure 7-4 does not show the shutter, which is a disk with a sector removed. The disk rotates 90 degrees to expose the character onto the output, once character selection and placement have been made. Direction of rotation is either clockwise or counterclockwise, depending upon which direction will make the open sector pass before the axis and expose the character. The disk rotates once for 1X and 2X magnifications and four times for 4X magnification; the additional rotations at the high magnification compensate for the lower light intensity and consequent reduced character blackness that would otherwise be produced. The shutter is positioned as shown in Figure 7-7.

Option Accessories

The reversion prism shown in Figure 7-4 is installed only on those machines that are fitted with the wrong-reading feature. Some filters and heat absorbers shown in the figure have not been singled out here for detailed consideration.

Only the wide-range Super-Quick Machine contains the magnification turret and other components associated with automatic variation of magnification. The less expensive standard machine has a fixed-power optical system, and consequently requires a size change at the character grid to achieve a size change at the output.

Functional Operations

The manner in which the Linofilm Super-Quick Machine uses codes from an input paper tape to control typesetting can be clarified with the help of Figure 7-7. It processes the codes for each line in two passes, the first to determine the amount of line remainder that must be divided among the interword spaces to justify the line, and the second to control the actual typesetting of the line, using an interword space that has been computed from the line remainder. The first operational pass is called Mode 1; the second pass, Mode 3; and the interval between them, Mode 2.

Mode 1

During the first pass (Mode 1), the tape reader processes the input tape until it reads an elevate code, which indicates the end of the line. The

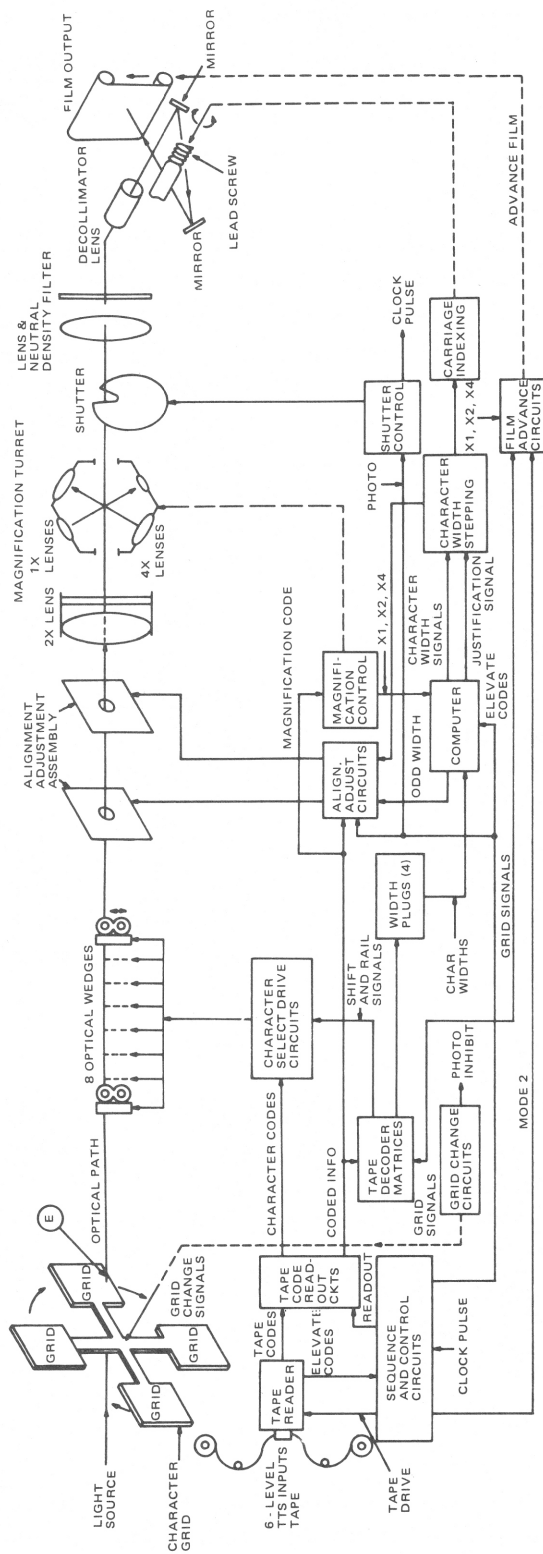


Figure 7-7. Circuit Schematic, Linofilm Super-Quick Machine

electric signals from each character code are sent to the tape code readout circuits, from which they are delivered to the tape decoder matrices as they are released by readout signals from the sequence and control circuits, the latter circuits having the function of controlling the sequence of operations within the machine. The tape decoder matrices decode the character and signal its identity to the width plugs, which output the set width for the decoded character and send it to the computer. (Width plugs are changeable, to provide proper set widths for the different fonts of characters.)

In the computer, the set widths are subtracted from the line length (entered manually unless the automeasure option has been installed), until an elevate code is received from the tape reader by way of the sequence and control circuits. This indicates the end of the line. Codes specifying magnification (X1, X2, or X4) are sent by the tape code readout circuits to the magnification control, which routes them to the film advance circuits, where they are used to adjust the character set width to allow for changes in character magnification.

Mode 2

The receipt of the elevate code by the sequence and control circuits also signals the end of Mode 1. The machine now starts to operate in Mode 2, during which the computer determines the size of the interword space required to produce a justified line when the line that has just been processed in Mode 1 is finally typeset in Mode 3. To do this, it divides the space remaining after the character widths have been subtracted by the number of interword spaces, and stores this value for use during Mode 3.

At the same time, the tape is reversed until the elevate code that precedes the one that has just been sensed is reached. This locates the start of the line that has just been processed in Mode 1, and assures that when the second pass (Mode 3) of the line through the tape head commences, the first character processed by the reader will be the first character in the line. During this operational mode, the output film or paper is also advanced into position to receive the line that has just been processed in Mode 1. A Mode 2 signal received from the sequence and control circuits initiates the advance.

Mode 3

Upon sensing the elevate code that corresponds to the start of the line, the machine shifts to Mode 3, which starts the second pass of the tape through the tape reader. During this pass, the tape codes are sent to the

tape code readout circuits, and coded information is routed through the tape decoder matrices and width plugs to furnish character widths to the computer, as before. This time, however, the computer passes the widths on to the character width stepping circuitry, which uses them to position the reflecting mirrors so that the characters will be properly separated as they are typeset on the line.

In addition, character codes are sent from the tape code readout circuits to the character select drive circuits for use in setting the wedges to select the desired character. Shift-condition and rail signals are also decoded at the tape decoder matrices and applied to the character select drive circuits to help select the wedges. (The shift condition signal indicates whether a character in the shift or unshift section of the grid is wanted, and the rail signal indicates which of the two fonts on the grid should be used.) When the character image must be deflected an additional $\frac{1}{8}$ point by the horizontal adjusting lens to position the character properly on the output, an odd-width signal from the computer is sent to the alignment adjustment circuits to initiate this.

When the tape code readout circuits process a code that specifies a new magnification, the code is routed to the magnification control, where it initiates the proper rotation of the magnification turret. The magnification control also sends magnification indications (X1, X2, or X4) to the computer, to adjust the set width as described in connection with Mode 1, and to the film advance circuits to help compute the film advance that must be made before the next line can be photographed.

Shutter Control

The shutter control actuates the shutter when a character is ready to be photographed. It also generates a clock pulse when the character has been exposed. This is sent to the sequence and control circuits, which then signal the tape reader to advance the tape to the next code. In this way the motion of the tape is synchronized with the operation of the mechanism.

Alignment Adjustment

Besides initiating, when needed, the additional $\frac{1}{8}$ -point horizontal displacement of the character as described, the alignment adjustment circuits control the small horizontal and vertical movements of the lenses in the alignment adjustment assembly that ensure precise alignment of the character. The coded information being extracted from the tape tells the adjustment circuits the location of the characters on the grid as they are being called for. From these, the circuits deduce the settings of the adjust-

ment lenses that will impart any slight horizontal or vertical displacement that may be desirable to ensure that a character from that portion of the grid will be precisely projected. The circuits are set at the factory by the manufacturer; no attention is required of the user.

Grid Change

Grid change signals are sent to the grid changing mechanism. They are also sent to the film advance circuitry for use in computing the amount of film advance. For example, if a larger-sized grid is used in a line, the film advance must be increased. Magnification cannot be changed during a line, but type style can be changed at any place in a line, provided the magnification has not been altered.

If two grids that call for different film advances (which will probably be the case if each has a different basic point size) are called for in the same line, the film advance actually effected by the machine will be the one standing highest in a priority list that has previously been entered into the machine at the film-advance preference wheels.

In this way, point-size changes within a line, which are not permitted if they have to be obtained by varying the magnification of characters from a single grid, can be obtained by using two grids that have different basic point sizes. Point-size changes between lines, of course, can be obtained without grid change by varying magnification in the normal way.

8. ELECTRONIC CHARACTER GENERATORS—OPTICAL STORAGE

As noted in Chapter 1, the development of high-resolution cathode-ray tubes made possible the electronic generation of characters for automatic photocomposition. With electronic methods, the selection and placement of characters can be accomplished without any moving parts except those associated with the movement of film between lines. Even here a good deal of line advance can be provided without moving the film. Output speed can thus be increased substantially.

Two principal classes of electronic photocomposers can be distinguished: those that both store and generate the characters electronically, and those that generate them electronically but store the master characters optically. The latter are treated in this chapter; the former, in Chapter 9.

The chief manufacturer of the machines that combine optical character storage with electronic character generation is the Mergenthaler Linotype Company, which uses the principle in both its high-performance page composer, the Linotron 1010, and its medium-performance Linotron 505. The latter is described next and is shown in Figure 8-1.

THE LINOTRON 505

Characteristics of the System

The Linotron 505 combines optical character storage with electronic character generation to produce high-quality phototypeset output on film,



Figure 8-1. System Photograph, Linotron 505

paper, stabilization paper, or photo-offset paper plates. It can mount four 238-character grids at one time, and is capable of producing 170 newspaper lines (11 picas) per minute. Each character on the grids may be reproduced at any one of 15 different type sizes, ranging from 4 to 28 points.

A number of options increase the capabilities of the Linotron 505. For example, the pi attachment provides 64 additional character masters, and the wide-range attachment boosts the top point size to 72.

System Configuration

Figure 8-2 diagrams the basic Linotron 505 system, some of its optional equipment, and the principal inputs and outputs. The basic system consists of a control unit coupled electrically to a reproducer unit. Character grids and material to receive the output are loaded into the reproducer unit, widths for the characters on the grids are loaded from eight-level paper tapes into the core storage of the control unit, switches on the control unit are set to specify right- or wrong-reading output and high- or low-resolution characters, and eight-level paper tape containing properly coded input copy is fed into the paper-tape reader that forms part of the control unit. The reproducer unit automatically produces galley of phototypeset copy on the output material that has been loaded into it.

The input copy can be properly coded onto the eight-level paper tape via a computer run, or it can be directly prepared at the optional Linotron 505 keyboard units. These keyboards obtain character-width information, used in breaking copy into lines, from the core memory of the control unit; therefore they do not function independently of the control unit. Up to

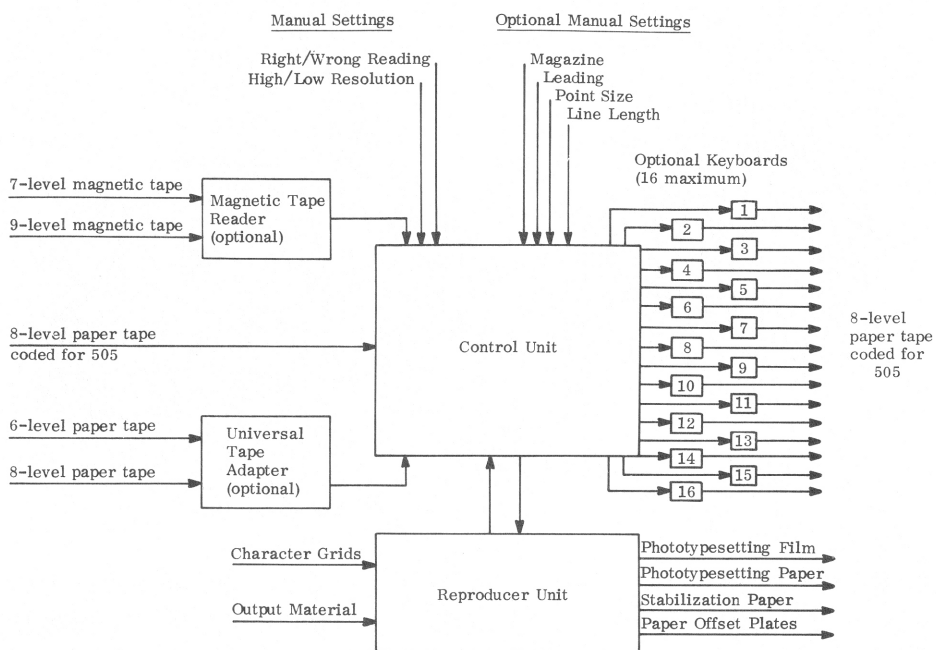


Figure 8-2. System Configuration, Linotron 505

16 keyboards can be multiplexed into the widths for 12 different grids. The widths are loaded from paper tapes when grids are installed in the reproducer unit, but are stored in a different portion of the core. Because of the multiplex feature, all keyboards can operate simultaneously, even though they receive width information from a single set of width tables.

In fully automatic operation, typographic parameters such as leading, point size, and line length are obtained from the input tape. However, they can be introduced manually at the control unit to override any values that may be coded onto the tape.

An optional universal tape adapter enables the system to accept other types of paper tape (six-level justified, six- or eight-level computer generated, or six-level wire service). An optional magnetic tape reader accepts seven- or nine-channel magnetic tape.

Functional Operations

The control and reproducer units of the Linotron 505, shown schematically with their inputs and outputs in Figure 8-2, are pictured individually in Figures 8-3 and 8-4. A reader for eight-level paper tape (one is furnished with the basic system; a second may also be installed), which rests on top of the control unit, provides a means of introducing input copy

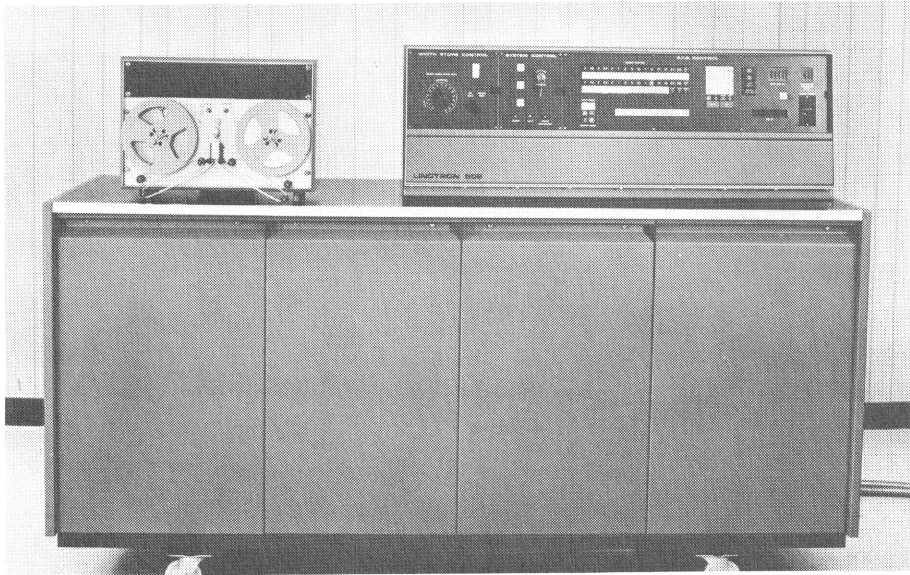


Figure 8-3. Control Unit, Linotron 505

(a line at a time) into the buffer storage, and of reading character widths into the core storage.

Succeeding lines of copy are stored in alternate buffers. While a line is introduced into one buffer, the previous line is read out of the alternate buffer for processing by the system. Buttons on the panel of the control unit permit operator intervention when necessary.

Operation of the entire system is directed from the control unit; consequently, there are very few buttons and switches visible in Figure 8-4, the photograph of the reproducer unit. A power on/off toggle on the reproducer unit applies power to the entire system. The controls at the upper left of the reproducer unit are part of a built-in exposure monitor that permits adjustment of output contrast and clarity. Brightness of the cathode-ray tube (CRT) that prints out the characters may be checked against an internal standard light; an oscilloscope in the small window to the left of the pushbuttons is used for calibration. The larger oscilloscope resting above the pushbuttons is part of an optional character monitor, which displays the characters as they are generated on the printout CRT.

Composing Capabilities

For the basic Linotron 505, the input copy is coded onto eight-level paper tape in either justified or unjustified form. Justified input (copy divided into lines that permit justification) is processed into galleys of

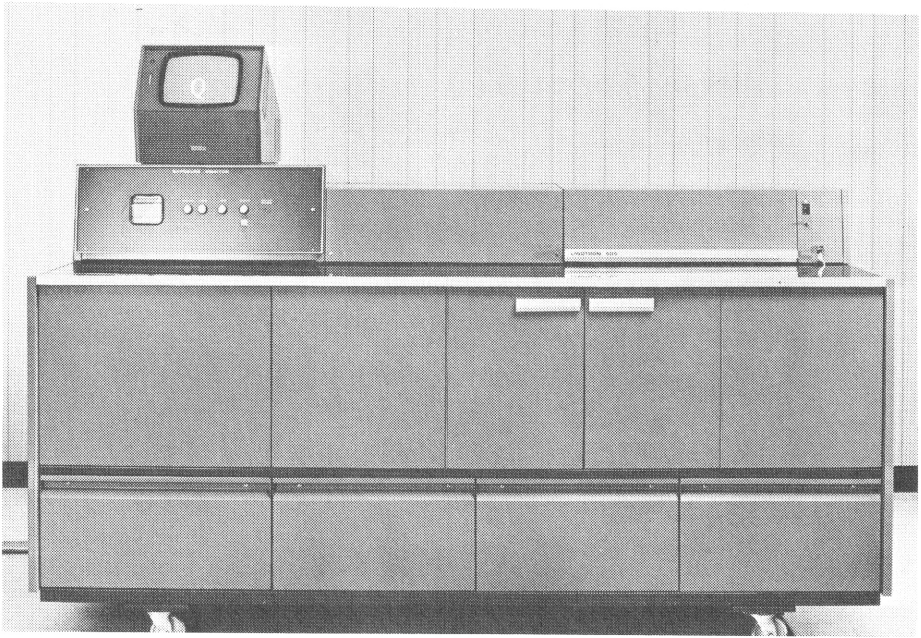


Figure 8-4. Reproducer Unit, Linotron 505

phototypeset output, using characters from four 238-character grids, which may each be set in 15 different sizes ranging from 4 to 28 points, as directed by the input tape. Unjustified input (copy not divided into lines) is processed into galleys of unjustified (ragged right) lines, each of which ends at the first interword space after a preset number of characters has been typeset. Lines of output may be automatically numbered if desired.

The grids in the machine are chosen from a large number of available ones, and any combination of four can be inserted into the machine at one time; therefore, the character complement may be changed to suit the nature of the input copy. Maximum line width is 64 picas; maximum output width, 11 inches. The operator can manipulate controls to call for right-reading or wrong-reading copy, and for low-resolution (650 lines per inch) or high-resolution (1300 lines per inch) characters. High resolution yields the most attractive copy and low resolution the highest typesetting speed; the manufacturer recommends low resolution for most applications. The usual assortment of output materials (phototypesetting film, phototypesetting paper, stabilization paper, and paper offset plates) may be used.

Machine capabilities can be expanded through added options, some of which were mentioned earlier. A list of options that significantly expand the capabilities of the Linotron 505 follows, together with an explanation of the capabilities added by each.

1. A *magnetic tape reader* permits use of magnetic tape. Either seven- or nine-track models are available.
2. The *universal tape adapter* permits use of six-level justified tape, six-level wire service tape, and six- or eight-level computer-generated paper tape.
3. A *pi attachment* permits extraction of characters from four 16-character plaques in addition to the four character grids normally in the machine. This provides a total of 64 additional character masters available in the usual 15 point sizes.
4. A *wide-range attachment* provides a 4X electronic enlargement of all type sizes up to 18 points.
5. The *mathematics option* enables the machine to set automatically all first- and second-order superiors and inferiors on any grid in their correct position, point size, set width, and alignment. This facilitates typesetting mathematical formulas.
6. The *variable start-of-line* permits the machine to set tabular work a column at a time. Up to four columns can be handled, and the carriage need return only to the starting point of a column instead of to the starting point for a line. This increases composition speed.
7. The *character monitor* is a small CRT that visually displays the characters as they are produced by the machine.

Character Production

Basic typography for the Linotron 505 is obtained from glass grid plates that contain positions for 256 characters, arranged in 16 four-by-four arrays. Eighteen of these positions are reserved for control functions; the other 238 are occupied by negative images of printable characters. Character generation and selection take place in three steps:

1. Optical pulse trains representative of the desired character and up to 15 others are produced.
2. The optical pulse train representative of the desired character is converted into an electric pulse train.
3. The electric pulse train is converted into a series of lines laid down on photographic film or paper to produce the desired character.

To accomplish Step 1, the grid plate is placed in front of a four-by-four array of lenses (Figure 8-5), behind which is a CRT whose working surface is projected by the lenses onto each of the 16 character arrays. When a signal calling for a particular character is read out of buffer storage, the electron beam of the CRT quickly produces a patch of closely spaced parallel lines, one after the other, on the section of its face (upper right in

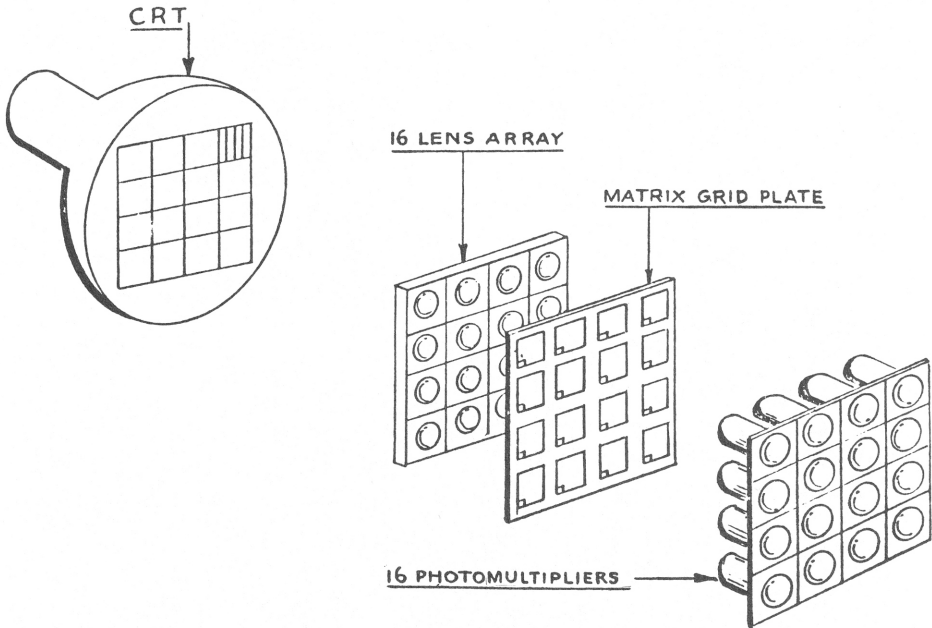


Figure 8-5. Scanning System, Linotron 505.

Figure 8-5) that is projected onto the portion of the grid that contains the character, and onto the portions that contain the 15 other characters that occupy the corresponding grid positions in their arrays. (In Figure 8-5, the positions thus illuminated are at the lower left of each array on the grid plate.)

As each line is painted on the surface of the CRT, each of its 16 positions will trace a line across a portion of the grid character that is receiving the projection. When the lines fall on clear portions of the grid (corresponding to black portions of the character), light will pass through the grid; when the lines fall on opaque portions of the grid (corresponding to white portions of the character), light will be absorbed. As succeeding lines of the patch are painted onto the tube, this absorption and transmission of their projections cause a train of pulsating light to emerge from each of the 16 characters receiving the projection.

Step 2 is performed with the assistance of 16 photomultipliers that receive the 16 optical pulse trains. When activated, these photomultipliers convert optical pulses to electrical ones. By activating only the photomultiplier that receives the optical pulse train from the desired character, the control logic of the Linotron 505 ensures that the electric pulse train emerging from the photomultiplier assembly will be the one corresponding to that character. Thus, the process of character selection, which began during Step 1 when optical pulse trains for 16 characters were produced, is

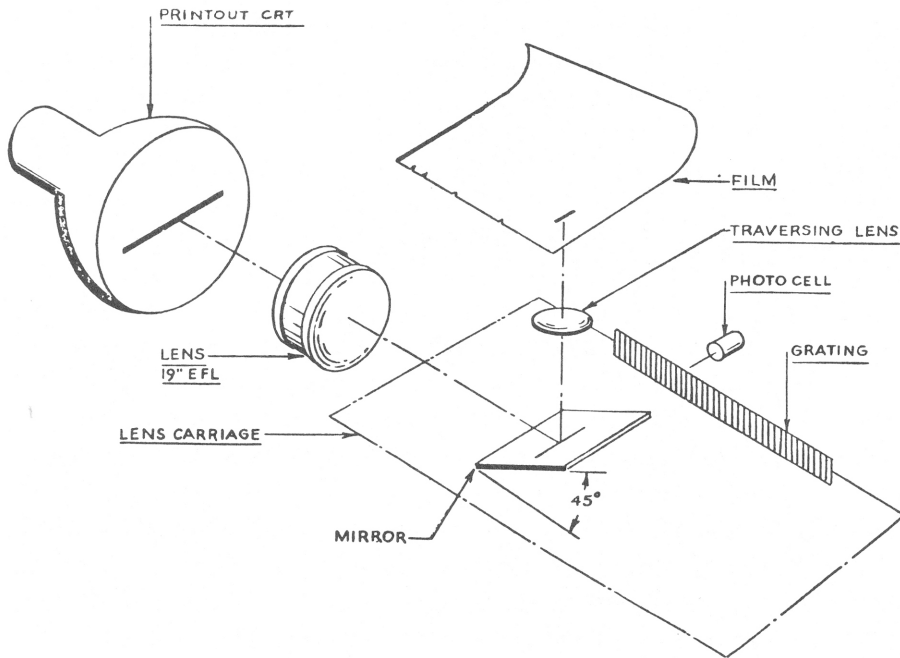


Figure 8-6. Printout Character Placement, Linotron 505.
(Reprinted with permission of the Mergenthaler Linotype Company.)

completed by ignoring 15 of those trains and converting to electric pulses only the train that comes from the grid master of the desired character.

Conversion of the electric pulse train into a phototypeset character (Step 3) is accomplished with the mechanism diagramed in Figure 8-6. The pulse train is imposed on the controls of the printout CRT in such a fashion that the tube face exhibits, one after the other, a series of superimposed traces whose light and dark sections correspond to the clear and opaque areas of the character on the grid as scanned during Step 1. Light from the traces is reflected by a mirror and imaged onto photographic film (or paper) by a traversing lens. Mirror and lens are mounted on a moving carriage together with a 650 line-per-inch grating that reflects light from a lamp (not shown on Figure 8-6) back into a photocell.

As a carriage moves, the rulings of the grating interrupt the light from the lamp to emit 1300 pulses per inch of travel; these pulses are converted by the photocell into electric pulses that time both the original scan (Step 1) and the printout CRT. Therefore, the projections of the traces can be positioned properly to build up the desired character on the film. The other lens in Figure 8-6 collimates the light so that the image on the film will be sharp, regardless of the position of the carriage.

To allow for variation in character width among characters of the same

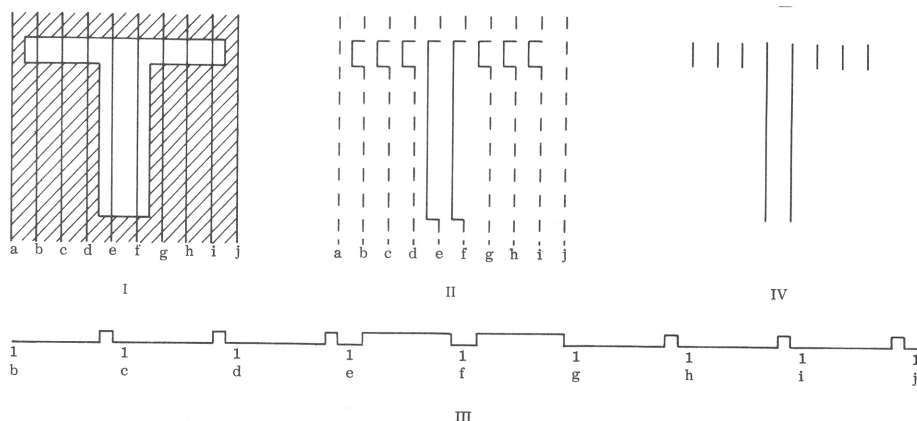


Figure 8-7. Simplified Schematic, Character Production, Linotron 505

set width, the number of scan lines is varied. When the input tape calls for a character, the pulses produced by the moving grating initiate lines that scan the grid master of that character until the grating, and the output film that travels with it, has moved an amount equal to the width. The next master character is then scanned by the number of lines that are initiated when the carriage movement equals the width on the output of the new character. This process is repeated until an entire line has been typeset. Either 1300 or 650 traces per inch can be produced on the output.

The width of the space required by a character will also change when set width changes, and the number of scan lines consequently will vary, much as it varies to allow for width changes among different characters with the same set width. In this case, however, the scanning density on the master grid must sometimes change to maintain the 1300 (or 650) traces per inch on the output, as required. The traces from the printout CRT are projected onto the output at 9.5X reduction.

For italic characters, the traces on the printout CRT are tilted about 12 degrees, so full kerning is possible. When a grid plate has been especially prepared for italics, the shapes of its characters allow for tilt of the printout traces, and the output characters therefore accurately represent the italic characters as they appear in the type catalog. Slanted type can also be produced from roman grids by tilting the printout traces, but the output will be typographically inferior.

Figure 8-7 presents a series of simplified diagrams that summarize this method of character generation. View I shows an upper-case *T*, clear body on opaque background as it would appear on a character grid plate. Imposed on it are 10 vertical lines, *a* through *j*, representing the projection of 10 scan lines from the face of the CRT. The transmission of light by the clear body of the letter and its absorption by the opaque background

creates a series of optical pulses, as diagramed in View II. These fall on the photomultiplier tube, to be converted there into the train of electrical pulses represented by View III. (The scale of View III is half that of the other views, and the portions of the train that correspond to traces *a* and *j*, which produce no current because the traces fall on opaque areas of the grid plate, are omitted.)

When the electrical pulse trace is imposed on the controls of the print-out CRT, the beam of the tube will trace a series of line segments on the tube face. The individual segments will be the eight shown in View IV, but they will be superimposed on one another instead of being separated as in Fig. 8-7. The traces are projected onto the output film or paper by the moving mirror and lens combination (Figure 8-6), and the motion of mirror and lens is synchronized with beam motion to separate the projections of the traces. The pattern of View IV is the result. Character height can be changed by altering the length of the traces shown in Figure 8-7.

In practice, the scan lines projected onto the grid are very tightly packed; thus, the lines of light projected onto the output will be extremely close to one another, and the output character is an accurate duplicate of the shape of the grid character.

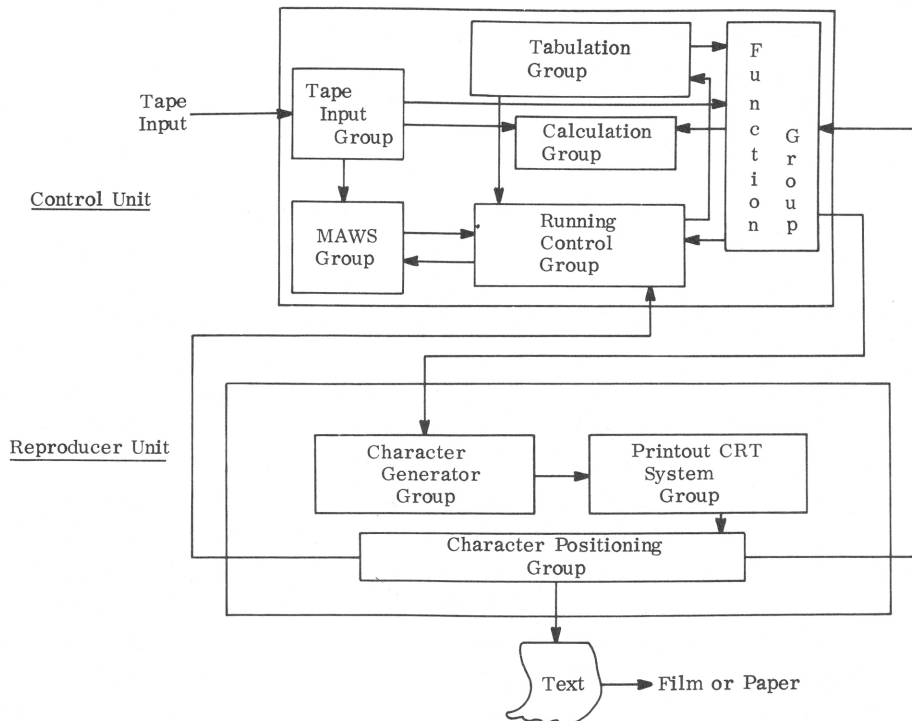


Figure 8-8. Block Diagram, Linotron 505

System Control

The character-generating, printout, and positioning mechanism described comprise the reproducer unit of the Linotron 505. Most control circuitry is housed in the control unit, which is connected to the reproducer unit by electric cable. Figure 7-8 is a block diagram of both units; the blocks representing the principal component groupings and the more important control interactions are indicated. These are briefly considered.

1. Circuits of the *tape input group* in the control unit control the tape reader, store groups of tape codes representing whole lines of text, alter the coding scheme to fit machine requirements, and present character and function codes to the rest of the machine at the required time. They also feed codes to the MAWS (multiple access width storage) group; before typesetting begins, character widths for the grids in the reproducer unit are loaded from special grid tapes into the MAWS group in this fashion. The input job tape is then placed in the tape reader and its codes are read and stored, a line at a time, in alternate buffers. As soon as a complete line is stored in one buffer, the tape input group starts releasing the codes, one at a time, to the function group; meanwhile, the codes for the next line are stored in the other buffer.
2. The *function group* contains circuitry for storing point size, set width, and interline spacing as well as circuitry for releasing them to the reproducer as they are needed during typesetting. These values may be introduced via manual pushbuttons, but normally they are coded onto the input job tape, and therefore stored in a buffer of the tape input group along with the character codes of the line.

When the code released from a buffer by the tape input group is a function code, its value will be stored in the proper circuitry of the function group. A character code, however, will be passed by the function group to the *character generator group* of the reproducer unit and used during printout. At the same time the output code for the character is sent to the MAWS group to call up the width of the character from the core store.

As obtained from core, the character width is expressed in eighteenths of an em, and therefore cannot by itself specify the actual linear dimension of the character, since the size of the fundamental 1/18-em unit depends upon set width. (For example, a 9-unit character with a set width of 12 points will require twice the linear dimension of a 9-unit character with a 6-point set width.) Therefore, the character width obtained from core is sent to the running control group, where it is multiplied by the set width (ob-

tained from the function group) to give character width in easily measurable units.

3. Circuits of the *running control group* time the entire sequence of printout processes, using as a master clock the pulses produced by the grating on the reproducer carriage in the *character positioning group*. The circuits count the number of pulses, and send a “new character” pulse to the tape input group when the count assures that the carriage has moved an amount appropriate for the character width. The pulses also trigger scan lines on the index CRT of the character generator group; these are placed on the tube so that the proper character will be scanned and phototypeset as described above.

In this way, the entire line is produced, one character at a time. The carriage returns to its zero position when the entire line is composed; the film advances the interline spacing that was previously stored in the function control group, and the composition of the next line commences.

4. The *calculation group* of the control unit calculates for each line the interword space required for justification, and supplies this to the running control group so that the proper interword spacing will be provided. The *tabulation group* calculates the start-of-line position or, in multicolumn work, the start-of-column position. The printout CRT system group of the reproducer unit comprises the printout CRT (Figure 8-6) and its associated circuitry.

Coding Requirements

Both character and instruction codes are supplied to the Linotron 505 by the input tape. Eight-level tape is used, but since one level is reserved for parity check, only seven levels are available for actual code construction. Of the 128 codes thus provided, a maximum of 119 are available to designate the individual characters themselves; the remaining nine codes comprise tape feed, erase, carriage return, rail, unrail, variable word space, single instruction code following, multiple instruction code following, and end of multicode sequence.

The instruction codes, most of which are really code sequences introduced by the “single instruction code following” or the “multiple instruction code following” codes, may be grouped under mechanical instructions (long processing time), carriage movement instructions (variable processing time), and fast instructions (processing time short enough to permit implementation of instruction between characters). They are so grouped in Table 8-1.

Table 8-1. Instruction Codes

TYPE	PROCESSING TIME	CODE
Mechanical	$\frac{1}{2}$ –2 sec.	Magazine Change Start Slant Stop Slant One Shot Leading
Carriage Movement	Variable	Advance to Tab Tab Ems Quad 1–18 Units Quad Out 1–126 Units
Fast	30 μ sec	Change Point Size Change Set Width Change Film Advance Stop Optional Stop Inhibit Film Advance Line Length Remainder Follows Pi Character Follows Variable Start Line
Other		Rail Unrail Variable Word Space Carriage Return

9. ELECTRONIC CHARACTER GENERATORS—ELECTRONIC STORAGE

The preceding chapter discussed photocomposers that generate characters electronically from optical masters. These provide the typesetting speed inherent in electronic character selection and the flexibility inherent in electronic character production, but retain the photographic type of character storage associated with the purely optical machines. Another type of photocomposer stores—as well as selects and generates—the characters electronically; digital data on magnetic tape replaces the photographic character grid used for optical storage.

It should be emphasized that the all-electronic machine possesses no inherent speed or flexibility advantages over the electronic character generators that store the characters optically; nor would one be expected, since both use electronic methods for selecting and producing the characters, which are the time-consuming stages in a purely optical machine.

It is worth noting that ingenious design can increase the speed of purely optical photocomposers. The Photon 902, for example, offered a maximum speed of 800 characters per second, which, while nowhere near the 6000 character-per-second maximum of the purely electronic machines described in this chapter, was considerably faster than that normally associated with optical photocomposition.

The two purely electronic high-performance photocomposers with the most sales in the United States are the Harris Intertype Fototronic CRT (Figure 9-1) and the RCA Videocomp. Both are described here.



Figure 9-1. System Photograph, Fototronic CRT

FOTOTRONIC CRT

Characteristics of the System

The Intertype Company's Fototronic CRT comprises two main groups of components: the photographic unit, containing the components that actually produce the characters, and the central processor, containing the components that control character production. Components of the photographic unit are normally housed in a single lighttight cabinet, which an operator can enter to load output material and to remove exposed output for photographic processing. The unit can also be placed in the user's dark-room without the cabinet. Control, logic, power-supply, and character-storage modules in the central processor combine to form one unit, connected electrically to the photographic unit by cables that run under the floor. As many as four character-storage modules can be included in a central processor, depending upon the character capacity desired, but only

one of each of the other modules is used. The control module includes a magnetic-tape reader.

Functional Operations

From a functional viewpoint, Figure 9-2, the Fototronic CRT may be treated as a combination of instruction-distribution, character-production, position-controlling, and CRT equipment. The instruction-distribution equipment reads the magnetic tape, distinguishes between character-selection and character-positioning information, and routes character selection to the character-production equipment and character-positioning to the position-controlling equipment. The image-positioning equipment receives the position information and delivers a film position to the camera

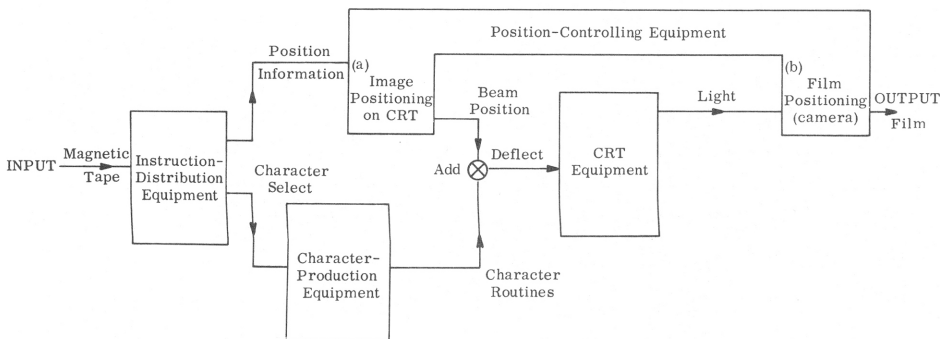


Figure 9-2. Functional Diagram, Fototronic CRT

and a beam position to the CRT equipment. When combined, these positions locate the character properly on the typeset line. The character-production equipment receives the character-select information and delivers character routines that combine with the beam position in the CRT equipment to produce deflections that generate characters. The characters are photographed onto output film or paper as fast as they are produced.

Interline Spacing

Interline spacing is provided by a combination of film advance and beam motion. Normally, the film advances the complete interline distance, as in most photocomposers. It is also possible to depress the beam as much as 12.4 points and to synchronize this beam depression with film motion so that the characters being produced will be horizontally aligned on the film. Therefore, typesetting of a new line need not await completion of the film advance. As soon as the moving film is within 12.4 points of its new

position, character production for the new line can start, with the beam position automatically shifted enough to compensate for the incomplete film advance. This feature permits continuous setting of characters without delay for interline film advance.

Film Advance and Unloading Output

Both positive and negative film advances are possible. There are no input or output cassettes, since the walk-in feature of the photographic unit makes them unnecessary. A red safelight inside the unit permits the removal of typeset output without disturbing operation.

Composing Capabilities

Output

The Fototronic CRT produces complete pages of textual copy phototypeset at high speeds according to instructions received from an input magnetic tape. Horizontal lines of copy can be arranged in complicated formats, incorporating footnotes, page numbers, headings, and run-arounds. Line rules, tables, and leaders are automatically produced from codes on the input tape. Multicolumnar pages with vertically justified columns can also be typeset.

Input

The input tape specifies type sizes from 3 to 28 points in half-point increments, and the machine automatically produces them upon call. When the size of the output characters is the same as the size on the master, the resolution is normally 720 lines per inch, since the character will be produced as a series of very small dots that are 0.1 point apart.

Magnification

Characters may be magnified by increasing dot separation and size, and may be minified by decreasing dot separation and size. However, the complete range of point sizes cannot be produced in this manner because both magnification and minification reduce quality if carried too far—the former because the dot structure becomes noticeable and the latter because excessive dot overlap will cause noticeable variation in stroke density. Therefore, the character masters are furnished in several basic sizes, each master providing only a modest range of output sizes; for example, the 5-point master normally produces an output range of 3 to

8 points; the 7-point master, an output range of 4 to 10 points; and the 10-point master, an output range from 6 to 14 points. Note that the ranges overlap.

Speed

Typesetting speeds are rated at 2000 characters per second from 5-point masters, 1000 characters per second from 7-point masters, 500 characters per second from 10-point masters, and 275 characters per second from 14-point masters. Actual speeds vary considerably with type style and type quality; in some cases, the speed may reach 6000 characters per second.

Capacity

Character capacity varies from 256 to 4096, depending upon the number of character-storage modules ordered. All characters that have been stored as roman can be automatically condensed, expanded, or obliqued during typesetting. Characters may be positioned horizontally within 0.001 inch of accuracy along any line length up to either 69 or 100 picas, depending upon the model. Positive or negative leading in 0.1-point increments are automatically produced upon command.

Either right-reading or wrong-reading (mirror image) output pages may be produced on phototypesetting film, phototypesetting paper, or stabilization paper, but all these media must be removed from the machine for processing. In addition, Polaroid copies (10-second development) with a maximum image area of 3½ by 4½ inches can be made for monitoring purposes if an optional Polaroid camera is installed.

Composing Method

Composing methodology for the Fototronic CRT is explained with the aid of Figure 9-3, a detailed block diagram that expands on the simplified diagram in Figure 9-2. The same fourfold equipment grouping is used, but the groups are divided into their component parts. The blocks that belong to the instruction-distribution, character-production, and CRT equipment groups are enclosed in dashed rectangles labeled with the name of the group. Component blocks not enclosed in a dashed rectangle are part of the image-positioning equipment.

Equipment

The instruction-distribution equipment has four main functions, each fulfilled by one of the subsystems represented by a block in Figure 9-3. The

tape reader transports and reads the magnetic input tape into a double buffer. Each buffer stores 1033 bytes of information for release to the image-positioning and character-production equipment as needed, and the double buffer permits simultaneous reading of input tape and generation of output. The decoder recognizes the instructions and directs them to the proper subsystems of the image-positioning and character-production equipment. The system controls unit monitors and controls the system.

Data Flow

Figure 9-3 shows the data flow through the tape reader, buffer, and decoder. The operation of each of these is controlled by signals received from system controls. Note that the tape reader and the decoder also send signals to system controls, which need information about the state of those two components in order to perform control functions properly. Other inputs to system controls come from components outside the instruction-distribution equipment, and signal when those components are ready to handle a new character or typesetting command. The decoder output divides as it leaves the instruction-distribution equipment, the signals pertaining to character identity going to the character-production equipment and the signals pertaining to character placement going to the image-positioning equipment.

Placement

Both horizontal and vertical placement of characters is accomplished by combining beam motion with motion of the output film or paper. The commands that affect vertical placement are sent from the decoder to the leading logic unit, which compares the desired output position with the actual position, as indicated by the position of the drive sprockets. If the difference is less than 1.6 points, leading logic commands the leading and rule converter unit to change the difference from digital to analog form and to apply the analog signal to the vertical deflection amplifier in the CRT equipment, which in turn raises or lowers the cathode-ray beam to provide the needed positive or negative leading. If the difference is greater than 1.6 points, leading logic directs the mechanical leading components to move the output vertically until the output position is within 1.6 points of the desired position, at which point the remainder of the leading is provided by beam motion. The output may be moved down as well as up. Typesetting continues while the output is moving if the dynamic leading feature is switched on.

As far as horizontal placement is concerned, the general scheme is to rely upon beam displacement for motion up to 11½ inches (which is deter-

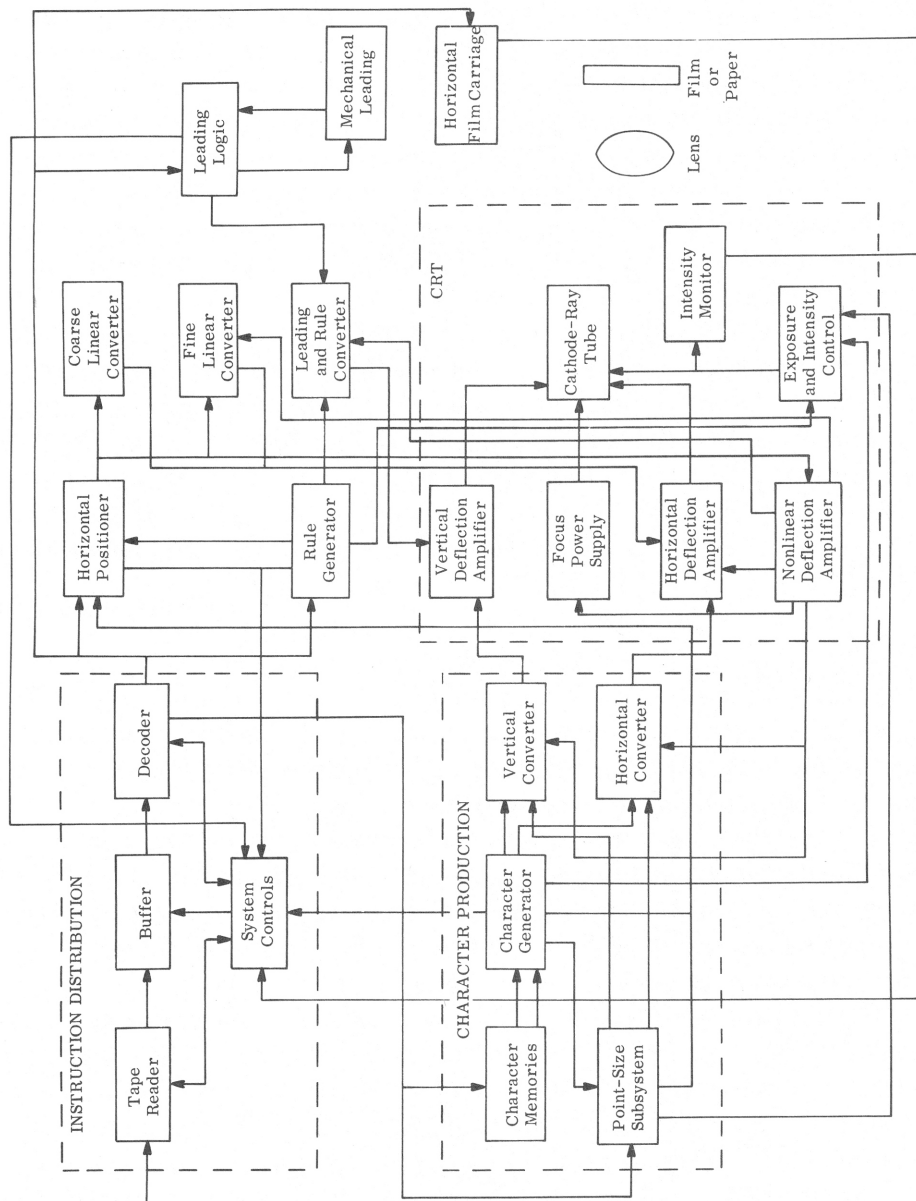


Figure 9-3. Block Diagram, Fototronic CRT

mined by the size of the cathode-ray display tube) and to shift the film carriage sideways if greater width is needed. The input tape must specify the method. Signals controlling motion of the film carriage are sent from the decoder to the horizontal film carriage in the image-positioning equipment, and the film carriage moves horizontally by the amount specified. Signals controlling horizontal motion of the cathode-ray beam are routed to the horizontal positioner. If the purpose of the motion is to provide white space, the size of the space is obtained from the decoder; in normal textual work, the sizes of commonly used spaces are stored in registers at the horizontal positioner, from which they can be rapidly extracted each time they are needed. (Sizes of spaces not stored in registers are obtained from the tape each time they are used.)

If the purpose of the horizontal motion is to position a character properly with respect to the character that immediately precedes it, the width of the preceding character is sent from the character-production equipment to the horizontal positioner. The positioner delivers digital signals to the coarse and fine linear converters, which output analog signals to the horizontal deflection amplifier in the CRT equipment, where they are used to move the beam of the CRT enough to provide the desired space.

Beam Manipulation

Once beam and film carriage are properly located to receive a character, the beam must be manipulated to paint it on the CRT. Details about character shapes are stored in a drum memory, and when a signal specifying a particular character is received from the instruction-distribution equipment, the character-production equipment produces a routine that causes the CRT equipment to generate the character as a series of small, overlapping spots (500 to 1500 per inch). Overlapping ensures that character edges will be smooth, as required for high-grade typography.

The pattern instructions required for moving the CRT spot are released from the character memory to the character generator. The generator produces a digital representation of spot location by totalizing the unit steps of spot movement as they are read from the memory, and sends the horizontal and vertical deflection amplifiers to position the spots properly. Vertical converters, which convert them to analog signals that enable the horizontal and vertical deflection amplifiers to position the spots properly on the face of the CRT. The character generator also releases an "expose" (unblanking) command to the CRT equipment, which turns on the beam to produce a spot each time the beam is properly positioned.

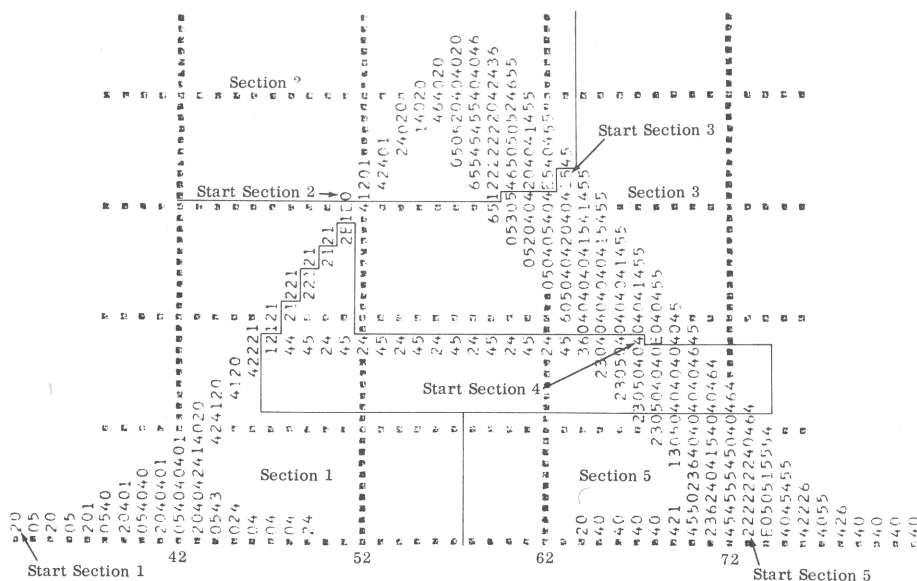


Figure 9-4. Generation of Character A

Character Production

Figure 9-4 is a graphical demonstration of character production as controlled by a typical routine. Each number stands for a type of spot motion, as presented in Table 9-1. The character in Figure 9-4 is divided into five sections, as indicated, and the routine for each section is stored separately on the drum along with the coordinates of the starting point. Therefore, character generation may commence with any section, a capability that reduces access time from 100 to 200 microseconds. The commands, which

Table 9-1. Key to Figure 9-4

NUMBER	INSTRUCTION
0	Increase reading of horizontal accumulator 1 step
1	Increase readings of both accumulators 1 step
2	Increase reading of vertical accumulator 1 step
3	Increase reading of vertical accumulator 1 step and decrease reading of horizontal accumulator 1 step
4	Decrease reading of horizontal accumulator 1 step
5	Decrease reading of vertical accumulator 1 step
6	Increase reading of horizontal accumulator 1 step and decrease reading of vertical accumulator 1 step
E	End of routine

Figure 9-4 places at the spot location from which the command is executed, are carried sequentially on the drum. For example, the first few commands for Section 1 are 2, 0, 5, 0, 2, 0, 5, 0 for the purpose of generating the small foot of the character. Point size of the stored character, the character width at that point size, and the number of sections that comprise the character are also associated with the routine for each section. (The latter ensures that the spot information for each section is read only once per character. Point size and character width are used by the point-size subsystem, as described in the next paragraph.) In practice, most characters are composed of more spots than are shown in Figure 9-4.

Magnification

In addition to the character memories and character generator, the character-production equipment incorporates a point-size subsystem to perform the computations needed for character magnification. The subsystem computes the ratios of the desired point size to the point size of characters in the memory, and then sends this information to the horizontal and vertical converters for the adjustment of signals from the character generator. These compensated signals bring about the formation of correctly sized characters.

Separate ratios computed for vertical and horizontal sizes make possible a variation in magnification with direction when required for good typography. The subsystem also multiplies the ratio of horizontal sizes by the width of the character in the character memory to obtain a true character width, and sends this information to the horizontal positioner of the image-positioning equipment to help position the beam for the next character. The point-size subsystem also computes the ratio of the true character area to the area of the character stored in character memory, and sends the result to the intensity control in the CRT equipment to adjust exposure time and dot size so that all characters will have equal density on the film.

Memory registers in the point-size subsystem store the horizontal and vertical point sizes as they are read from the tape, and no additional indications of size need be carried on the tape until the sizes are changed.

Correction

Corrections for potential nonlinearity in the CRT display are initiated by the nonlinear correction unit in the CRT equipment, under control of the horizontal position reference indication received from the horizontal positioner in the image-positioning equipment. Character-deflection correction signals are applied to the horizontal deflection amplifier, character-size corrections to the horizontal and vertical converters, and focus corrections to the focus power supply. (All of these items except the converters are located in the CRT equipment.)

Rules

The rule generator utilizes instructions from the decoder to produce a routine that fixes small spots at intervals of 0.1 point until the rule is completed. Horizontal steps required by the rule are converted by the horizontal positioner from a digital code to analog signals that effect the desired horizontal deflection sequence of the CRT beam. Similarly, the leading and rule converter converts a digital code representing a vertical rule to analog signals that effect the needed vertical deflection sequence. Reference to Figure 9-3 will establish the exact signal flow in both cases.

As soon as the characters and rules appear on the face of the CRT, they are imaged onto the film or paper to phototypeset the line.

Coding Requirements

When a Fototronic CRT is ordered, the buyer specifies whether it is to operate from 7- or 9-level magnetic tape, or he specifies a combination 7- and 9-level tape transport. For convenience, the description here assumes the use of 9-level input. Adaptation to the 7-level case is straightforward.

The input tape contains a series of 9-bit bytes arranged side by side on a magnetic tape, and all nine bits of a byte are read simultaneously from the tape by a 9-channel tape reader. The bytes are organized into blocks of 12 to 1034 bytes each.

Blocks

The first eight bytes of each block give book, page, and block numbers to make possible the automatic location of a desired item by the tape transport. From 1 to 1023 bytes carrying instructions and character addresses follow. An end-of-block byte and two bytes for longitudinal parity and cyclic redundancy checks complete the block.

Instructions are given by two types of bytes. When the command must be followed by data (for example, a command to draw a rule must be followed by the dimension of the rule), the second, third, and fourth bits are all 1s. When the command need not be followed by data (for example, a command to cut the film), those bits are all 0s. In both types, the first bit is a parity check, and bits 5 through 9 identify the command.

When a command byte must be followed by data, it is followed by three data bytes. Such bytes carry a 0 as bit 2, a 1 as bit 3, and the data in bits 4 through 9. Here, again, the first bit is for the parity check.

Character addresses are given in bytes that carry the band number (bits 2, 3, and 4) and the track number (bits 5 through 9). Selection of the

particular memory and subset in which the band and track are located is made with a command to change subsets, followed by data to identify memory and subset.

An input tape of this type cannot be provided by simple keyboarding, but requires the action of a properly programmed computer. A typical system, the HCS (Harris Composing System), uses an IBM System/360. Systems using other computers can also be devised.

In the HCS, formatting instructions are first coded onto the tape as an alphabetic character (A to Z) followed by a numeral (1 to 9), both enclosed within delimiters. Each of these pairs, called *macros*, represents a series of two-letter codes, sometimes as many as 500, which gives a single formatting instruction. By introducing each series as a single macro, it is possible to manipulate the tape independently of composition considerations. At composition time the macros are replaced by the series of two-letter codes that correspond to them, after which the information is blocked and formatted.

Figure 9-5 diagrams the preparation of information for the system as well as the data flow through the HCS itself. The macros can be perforated onto the paper tape while being keyboarded from the manuscript; or if the information is already coded into identifiable fields, the macros can be embedded onto a magnetic tape by a computer run that is controlled by TABTXT, a preprocessing program. The paper-tape output from the keyboard, normally in teletypesetter code, is converted to magnetic tape in extended binary-coded decimal code; and the converted tape (or the original output tape if TABTXT is used) may be edited, updated, or otherwise manipulated without concern for format details. In fact, formatting

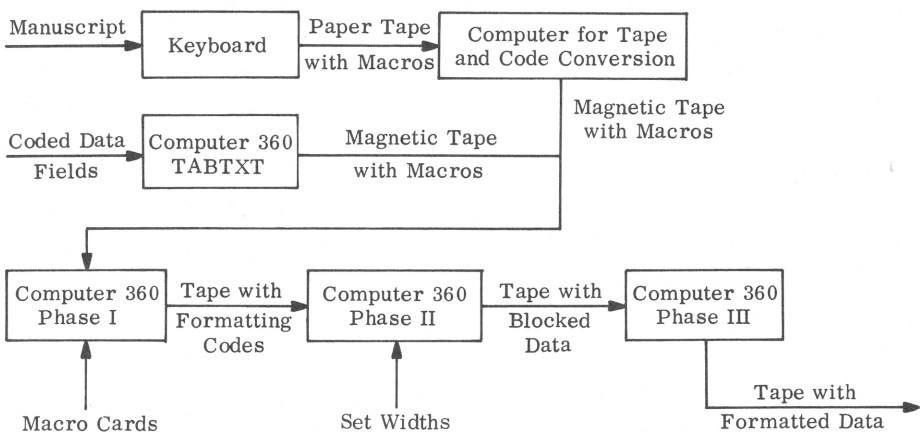


Figure 9-5. HCS Composing System, Fototronic CRT

parameters need not be assigned to the macros until the start of the processing through the HCS.

Phase I

Phase I of the HCS replaces the macros with the actual formatting instructions; for example, the macro <A1> might be replaced by a series of two-letter codes that stand for centered lines, 10-point type, 30-pica column width, and 12-point film advance. The tape output by this phase consists of the character codes and the two-letter formatting codes.

Phase II

Phase II of the HCS composes the lines of copy, including hyphenation and justification, making use of the format commands. Character addresses and widths, obtained from disk storage, are assigned during this phase. The output tape contains line segments, page records, and block information. Line-segment records contain block number, line number, vertical justification flag, horizontal and vertical coordinates, character codes, and instruction codes. Page records contain the number, width, and depth of each page and a page flag. Block information records contain block origin and boundary information.

Phase III

Phase III of the HCS makes up the page, including vertical justification, and translates the data controls to forms that can be used by the photocomposer. Line segments are arranged so that they can be set without using the reverse-leading capability of the Fototronic CRT. The output tape from this phase is used to drive the photocomposer.

Errors

Phases I, II, and III are coded in assembly language. Error messages are listed whenever appropriate, and typesetting continues after the error has been noted.

THE VIDEOCOMP PHOTOCOMPOSER

The RCA Videocomp 70/800 Series (Figure 9-6) are high-performance photocomposers that produce completely made-up textual pages under

the control of an input tape. Characters are generated and displayed electronically. The photocomposers produce horizontal lines of justified copy containing characters of different sizes and type styles, and assemble them into complicated page layouts. Complete formatting information must be on the input tape, the production of which requires a computer.

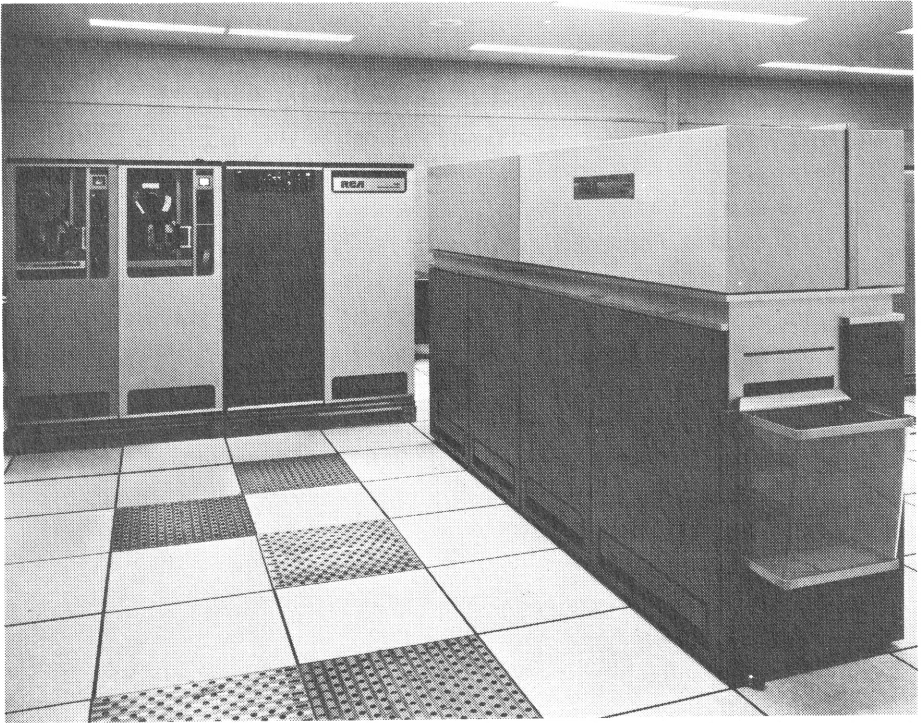


Figure 9-6. Videocomp 70/830-270

Characteristics of the System

Figure 9-7 diagrams the equipment configuration for the 70/800 Videocomp Series. Items drawn with solid lines apply to the basic 70/800 machine. Dashed lines indicate options that require an RCA 803 console typewriter in the system.

The Basic 70/800 Videocomp does not require an RCA 803 console typewriter, and either of the two tape stations can process the input job tape. An additional core memory may be supplied as an option with this configuration to produce a machine identical with the 70/830-270. The 35-mm microfilm option may also be used without the console typewriter, although RCA recommends that the latter be combined with the full-face writing option discussed next. All other options require the console typewriter to enter commands into the control unit and to read out error

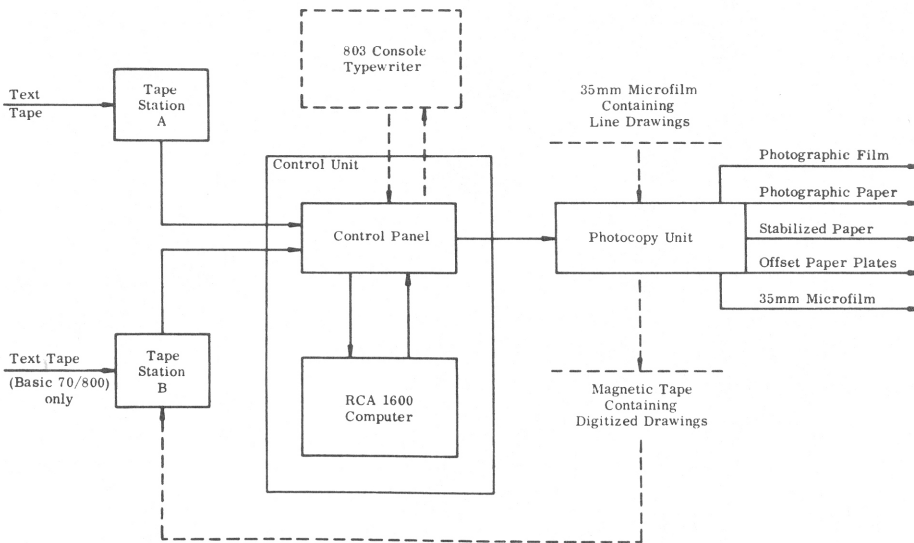


Figure 9-7. Equipment Configuration, Videocomp 70/800 Series

signals. In that configuration, the input job tape is restricted to tape station A.

Once the RCA-803 console typewriter is installed, a number of options become available. Area-composition capabilities are added by the full-face writing option. Line-drawing capabilities are added by the drawing scanning option (to make a digitized drawing tape) and the drawing writing option (to output the drawings onto photographic film, photographic paper, stabilization paper, or offset plates). Vertical lines of type are set with the image rotation option, which permits the production of turn pages and facilitates the drawing of line rules. An optional disk storage is used to store the digitized fonts of characters, making it unnecessary to write them repeatedly on the input text tape. Options are listed in Table 9-2. RCA provides the programs needed by the control unit to direct the various Videocomp operating modes.

The RCA Videocomp 70/840 Series generate their characters electronically and display them on the face of a CRT one line at a time. The magnetic tape input contains the desired text and formatting codes. Output is textual pages photographically produced on a variety of output forms. Typesetting speeds depend upon type of copy and quality desired in the output; maximum speeds of 6000 characters per second are claimed. Fonts of characters are prepared in digitized form so that they can be output on a CRT.

Table 9-2. Videocomp Options that Require RCA 803 Console Typewriter

FEATURE NO.	TITLE	CAPABILITY PROVIDED	ADDITIONAL PREREQUISITES
F8009	Full Face Writing	Composes 7 x 9 inch page without advancing output media	None
F8010	35 mm Microimage	Produces output on 35 mm microfilm	F8009 recommended
F8011	Disk Storage	Provides random access storage for fonts, logotypes, electronic forms, etc.	None
F8013	Image Rotation	Rotates orientation of typeset lines 90°	F8009
F8014	Drawing Writing	Produces line drawings from digitized drawing stroking data	F8009
F8015	Drawing Scanning	Digitizes line drawings from 35 mm microfilm	F8009, F8010

Composing Capabilities

Briefly stated, the Videocomp read character codes from an input tape, operate upon them, and produce the characters on the face of a CRT in the size, style, and position called for by other codes on the input tape. The characters are rapidly produced in succession on the tube to compose a line of copy and are automatically recorded on the output material as fast as they are produced. When a line is totally composed, the output material is advanced the correct interline distance as directed by the input tape.

The Videocomps can arrange the horizontal lines of copy in complicated formats, incorporating footnotes, page numbers, and runarounds. Type styles and sizes may be mixed within a line. All layout variation is under the control of the input tape, which must contain all forming information.

Composing Methods

Each character is produced by an electron-scanning beam that strokes it on the tube face with a large number of vertical lines. The beam is



Figure 9-8. Electronic Character Generation

turned off and on at appropriate intervals, resulting in line segments that compose a solid character (Figure 9-8). The process is similar to that of commercial television except that (1) only the portion of the tube containing a character is scanned; (2) the scanning beam moves vertically instead of horizontally; and (3) the density of the scanning lines is much greater, to ensure sharply defined letter boundaries.

The scanning density may be set at several values from 112.5 to 1800 strokes per inch. The higher scanning densities produce the best output, but the lower scanning densities produce the highest speed.

Character Fonts

In the Videocomps, character generation as well as character display is electronic. Fonts of characters are prepared by analyzing them into a series of vertical lines and then storing the coordinates of these lines on tape. The coordinates for the fonts needed to compose a particular job are read into the Videocomp from magnetic tape before the actual typographic composition starts (or during composition if necessary) and are stored in core memory. These coordinates indicate where the scanning beam must be turned on and off to produce the character.

When a character is called for by the input tape, its scanning coordinates are extracted from memory, operated on to adapt them to the proper point size and to certain typographical parameters, and used to control the electron beam as it produces the character on the face of the cathode-ray tube.

The fonts themselves are called VideoFonts by RCA. Each basic font contains the coordinates for 80 characters. Each of these characters can be altered electronically by the Videocomp to form italics, condensed, extended, small cap, superior, and inferior versions of the basic type face. These altered type faces will sometimes be considered typographically inferior to a type designed especially for the letter form desired, but in many cases they offer a completely adequate method of obtaining typographic variety without having to invest in special fonts.

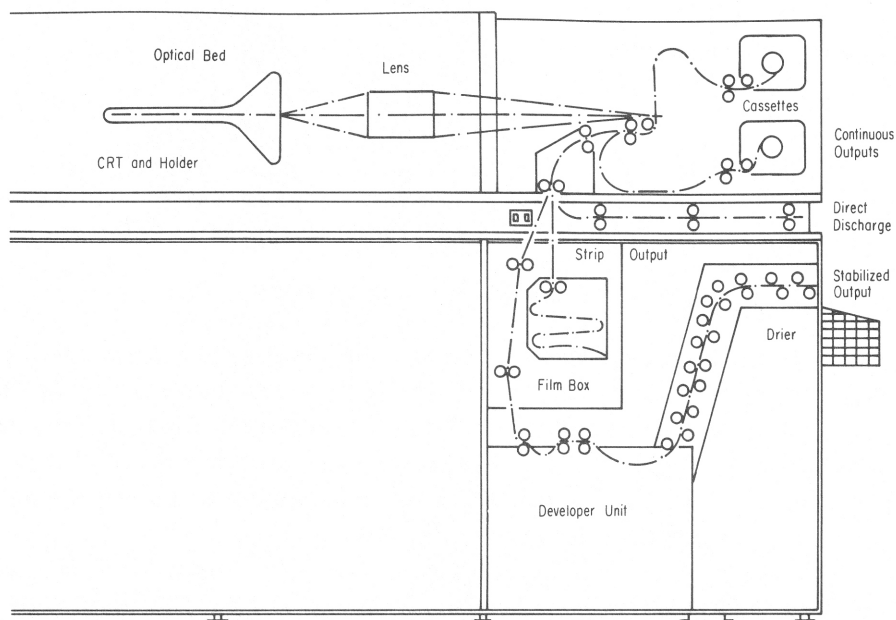


Figure 9-9. Sectional Schematic, Videocomp 70/830-270 Photocopy Unit

Variation of type size is effected in the Videocomp by varying the magnification of the font character electronically. This is much faster than varying magnification optically, since no moving parts are needed. To take full advantage of the point-size capability of the Videocomp, the basic VideoFonts are supplied in five size ranges: 4 to 8 points, 8 to 16 points, 16 to 32 points, 32 to 64 points, and 64 to 96 points.

The entire operation is controlled by an input tape, which carries the copy being composed in a coded, completely formatted form. It is important to realize that the Videocomp is a slave machine, completely dependent upon its input tape; consequently, the input tape must carry complete formatting instructions as well as the characters to be typeset.

The Optical System

At the output end, the characters produced on the surface of the CRT are imaged on the output material by a simple optical system (Figure 9-9) that has a fixed magnification of 1.93. When the 35-mm microfilm option is ordered, it is possible to change the magnification to 0.24 by swinging another lens into the system in place of the regular one. Both lenses are permanently mounted on a quick-range mechanism, so that the shift can be easily performed by the operator. A vacuum platen holds the output material flat.

Figure 9-9, a cross section of the photocopy unit, illustrates the simplicity of the optical system. It also shows the mechanism for handling different types of output material.

The output material remains stationary as the line is composed. There is no shutter; the characters are projected onto the output as fast as they are composed. After a line has been composed, the output material is advanced the interline distance (specified by the input tape) into position to receive the next line. This process continues until a page has been composed, after which a larger (usually 1½ inches) advance is made. Composition of the next page then begins.

Optional Capabilities

When the drawing scanning option is supplied, a small triangular box containing a photocell pickup is placed behind the aperture frame that holds the 35-mm microfilm during exposure in the microfilm mode. (The Videocomp must be equipped with the 35-mm microfilm option if the drawing scanning option is to be used.) Instead of loading unexposed microfilm in the magazine, the operator loads and feeds into the aperture a roll of processed 35-mm microfilm that contains copies of the drawings. This microfilm, which is produced externally to the Videocomp system, contains a bottom boundary mark and an upper boundary mark, a bar-code identification mark, and an alphanumeric identification mark for each drawing. (These marks may be stripped into the microfilm after development, or they may be placed on the original drawing and copied photographically during the microfilm process.)

During the drawing scan, the CRT of the photocopy unit scans the aperture from bottom to top as if it were exposing a page of output onto unexposed microfilm. In this case, however, the scan lines fall on the microfilmed drawing, sweeping across it from bottom to top. When they fall on clear film, they pass through to the photocell, causing the cell to emit a signal. When they fall on a dark line, they do not pass on to the photocell, and no current is emitted. In this way, the microfilmed drawing is analyzed into a series of electric impulses that can be compressed and stored on magnetic tape. The identification code is scanned separately and included on the magnetic tape as a control record. The bottom boundary mark and the upper boundary mark are used by the scan, as the rays from the CRT sweep across the microfilm aperture, to position the drawing and to determine its size prior to scanning it.

The magnetic tape containing the digitized drawings is mounted at Tape Station B (Figure 9-7) of the Videocomp. The input text tape, which contains the identification numbers of the drawings and the space that has been properly sized and located to receive them, is mounted at Tape Sta-

tion A. The control unit, properly programmed, causes the photocopy unit to produce both text and drawings, with the drawings properly located in the body of the text. Maximum size of the drawings is 7 x 9 inches, and the entire drawing must be produced on the output without moving it. Therefore, the full-face writing option is a prerequisite for the drawing writing option, since otherwise the maximum area is a rectangle 70 picas long and only 96 points ($1\frac{1}{2}$ inches) high, enough for no more than several lines of type.

The full-face writing option is also useful in some textual composition, since it permits composition of a 7 x 9 page without advancing the output, and the write control, text program (P9121-1) can produce text in either the line-by-line mode (similar to that used in the 70/830 Series Videocomps) or the full-face mode. Rotating the image so that lines of text run in a vertical direction is also possible because of the enlarged aperture, but requires the image rotation option (F8013). This option makes possible the setting of turn pages, as well as the production of 35-mm microfilm that can be easily converted into the types of 16-mm microfilm that carry text lines parallel to the edge.

The image rotation option also makes possible the production of 9 x 7 drawings by rotating the 7 x 9 inch output, and it facilitates the drawing of line rules. In the basic Videocomp, these rules are normally built up by a properly located series of aligning dashes. With the image rotation option, the rules can be produced by merely specifying the coordinates of their starting points and their lengths.

The disk storage option (F8011) consists of an RCA 70/564 disk storage unit, which provides an additional storage capacity of 7.25 million eight-bit bytes. Normally, it is used for storing digitized fonts and logotypes, making it unnecessary to carry them on the primary input tape.

Output scanning frequencies for drawing may be 225, 300, or 450 lines per inch. Normally, the scanning frequency used during the digitizing is the one corresponding to the desired output scan, since it produces a drawing that is the same size as the original. However, it is possible to output a drawing at other than the scanning frequency. In this situation, the size of the drawing on the output will be related to the size of the original as the scan frequency of the original is related to the scan frequency of the output. Thus, a drawing scanned at 450 lines per inch and written out at 300 lines per inch will be produced at 1.5 times the size of the original.

The text tape is called the primary tape and the drawing tape the secondary tape. In some cases, the digitized drawing information is placed directly on the primary tape along with the text. If this is done, it must be placed properly with respect to the text, since the contents of the primary tape are processed in sequence.

Coding Requirements

Since the data needed to control character production is stored in the core memory of a Videocomp, the basic functions of the machine code are to provide a method of addressing the characters as they are needed for typesetting, and to provide codes for the necessary typographic instructions. The characters of a font are assigned numbers, and are stored in numerical order in the section of core assigned to the font. Font location is first addressed by a font-select code, after which the individual characters are addressed by the numerical code that has been assigned to them.

Formatting information as well as the character codes must be carried on the input tape. This information takes the form of function codes followed, when appropriate, by numerical values indicating the extent of the function. Thus, after a font-select code sequence indicating the type face, the tape might carry the character codes for the first word, after which a space-forward code would be followed by codes giving the size of the interword space that should be inserted to assure that the line, when composed, would be justified. Character codes for the next word would follow, and then another space-forward code with the size that had been assigned to that particular word space. When the code for the last character in the line had been reached, an advance code would be inserted, followed by codes giving the amount of film advance required to move the output into position to receive the next line. Codes for that line would follow.

Software

Since the input tape for the Videocomp must contain completely formatted data, the raw data must be processed by a computer before it can be used as input. This can be accomplished in a number of ways, using any one of several computers. RCA supplies a 70/9300 graphic processing system for normal book-type copy.

Markup

The original manuscript, which will normally consist of typed sheets containing paragraphs of copy, must first be marked to indicate the nature of the formatting. Marking is facilitated by the RCA composition language system, an 82-word language in which each word is spelled by a unique combination of two letters. For example, quad left is QL, justify is JV, and paragraph is PR. The user writes statements with these words to describe the desired format, and stores these formats in the computer. (Each format has a two-character name from A1 to z9.)

The user then inserts the format names on the manuscript at their points of application and keyboards a paper tape incorporating these format statements into the text. Up to 100 different keyboards with their own codes can be used. Format statements can be written once, stored in the computer, and used for many jobs. With the proper use of language, commands, variations in page size, column width, point size, and similar requirements can be executed without rekeyboarding. Repetitive phrases and running heads may be keyboarded once and recalled whenever required. Pages are automatically numbered as the text flows from page to page. When corrections are added, pages are automatically recomposed and new page numbers generated.

Analysis

Three passes through a Spectra 70 computer are performed in the 70/9300 graphic processing system (Figure 9-10). In the first pass, the instructions from the composition language system and the keyboarded codes are translated into codes that can be executed by the system, and the input is analyzed to guard against miscoding.

Formatting and Blocking

The magnetic-tape output from Pass 1 is processed by Pass 2, which formats the copy into lines and pages in accordance with the formatting instructions. The formatting task includes justification, hyphenation, pagination, and so forth. Font set-width data, which have been stored on disk, are used during this pass to justify the lines.

Pass 3 takes the formatted magnetic tape that has been produced during Pass 1, organizes the data into blocks, and adds font data for loading into the Videocomp. This is necessary because the Videocomp, since it can

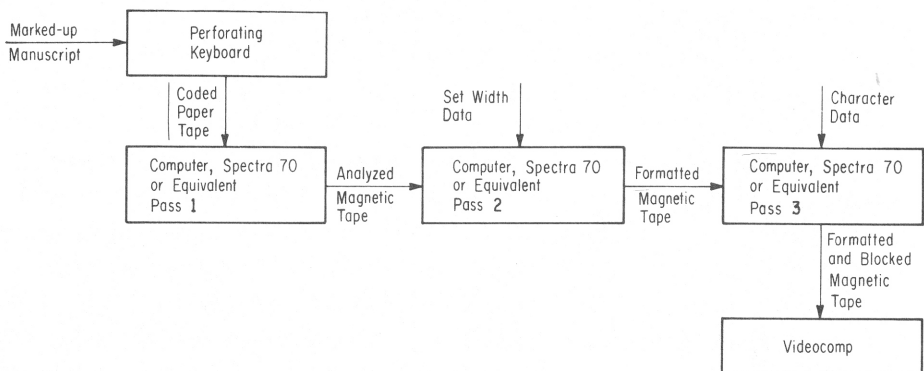


Figure 9-10. Block Diagram, 70/9300 Graphic Processing System

advance its output in only one direction, must process lines in the order in which they will appear on the output page. This will not always be the same as the order that they have on the original tape; a most straightforward example of this is multicolumnar copy. The formatted and blocked tape serve as input to the Videocomp.

Proof Copies

The 70/9300 graphic processing system may be used in the production of two different types of proof copies. It can produce a computer printout that indicates the formatting information by codes, or it can direct the Videocomp to insert line numbers in the output. Either of these can be proofread against the original copy. A correction tape that locates the corrected matter by line number and word number within the line is then prepared and merged with the incorrect tape to produce a new, error-free tape. This merger takes place after Pass 1 or after Pass 2.

10. SUMMARY

The preceding chapters demonstrate that automatic photocomposers differ widely in performance capabilities. They also show that many manufacturers are active in the field. It is interesting that some of the manufacturers are old-line makers of typesetting equipment (Mergenthaler Linotype, Harris Intertype, for example); others were originally known for products far removed from typesetting (RCA, Friden); and still others are companies organized primarily to promote particular kinds of typographic equipment (Compugraphic, Photon).

In making their entry into photocomposition, the old-line typographic manufacturers had some advantages. They knew the typesetting process and had numerous contacts with users of typesetting equipment; consequently, they knew what capabilities would be valuable to the typesetting establishments of the day. Paradoxically, this was not always an advantage, since in their attempts to satisfy the wants of many different typesetters, some of the manufacturers tended to price their machines too high for small composing rooms. The manufacturers saw the problem, but believed that small shops would merge until their volume justified the more expensive machines. To some extent this happened, but many small newspapers and trade composers found their way to profitable operation via cheaper, less flexible machines.

Companies organized primarily to promote particular photocomposers have had both successes and failures. They were often able to develop their machines faster than the older manufacturers. In the early days, particularly, some of them suffered from lack of typographic experience: one

manufacturer, for example, announced a machine that could not produce usable output on paper—a most important medium. Needless to say, he corrected this mistake quickly. The newer companies also had to develop sales and service organizations from the bottom, which put them at a competitive disadvantage with the older manufacturers. On the positive side, the fact that they depended upon photocomposition for their very survival probably led them to commit a higher portion of their revenue to improving their machines, and may have contributed to the number of their successes. The two machines that made the greatest initial impact when introduced, Photon 713 and Compugraphic 2900, were products of firms especially oriented toward phototypesetting.

Companies outside the typesetting field came to photocomposition by different routes. Some of them produced components used in other parts of the composing process (perforating keyboards, for example) and decided to extend their capabilities into actual typographic composition. Others thought they saw in automatic photocomposition a potentially profitable avenue of diversification and therefore committed substantial amounts of money to the pursuit of it. Some of these companies shared the lack of typographic expertise with the specially organized companies, but they usually had more extensive sales and service organizations. They have had their share of success and failure.

One of the problems faced by all manufacturers is in maintaining a proper balance between quality of typographic output and cheapness of manufacture. In favor of emphasizing economy at the expense of quality typography is the fact that most readers have little conscious concern for typographic refinement. In favor of emphasizing output quality is the belief that readers react favorably to quality, even though they may not consciously analyze it, and the unquestioned fact that the owners and foremen of typographic establishments, who usually decide what equipment to buy, do appreciate typographic excellence.

It has proved difficult to be completely certain about the right balance for a piece of equipment until the equipment is offered for sale and its market penetration has been measured. Marketing experience over the past few years indicates that (1) there is considerable reader acceptance of textual matter that does not meet high standards of typographic design; (2) if the price is low enough, typesetting establishments are willing to buy equipment that produces lower-quality textual output; (3) high-grade textual typography continues to be wanted by readers of quality magazines; and (4) high-quality typography gives sales impact to display advertising.

Indeed, the past 20 years of development in photocomposition have produced a few outstanding successes, a few dismal failures, and a large number of machines that, although not meeting the sales goals originally

set by their manufacturers, have enjoyed enough popularity to warrant continued production. This is probably the result that should have been anticipated from the outset, but each manufacturer, of course, originally expected his machine to make a sizable impact on the market. In addition, some manufacturers did not allow for the rapid technological advances of the past decade and anticipated a longer period of market dominance than their product warranted.

APPENDIX: MANUFACTURERS DIRECTORY

Alphatype Corporation, 7500 McCormick Boulevard, Skokie, Ill. 60076

American Type Founders, Box 48, Nashville, Tenn. 37202

Compugraphic Corporation, Industrial Way, Wilmington, Mass. 01887

Fairchild Graphic Equipment, 221 Fairchild Avenue, Plainview, N.Y. 11803

Friden (*See* The Singer Company)

Graphic Systems Inc., 217 Jackson Street, Lowell, Mass. 01852

Intertype Company, Division of Harris Intertype Corporation, 215 U.S. Highway No. 22, Watchung, N.J. 07060

Mergenthaler Linotype Company, Mergenthaler Drive, Plainview, N.Y. 11803

Photon, Inc., 355 Middlesex Avenue, Wilmington, Mass. 01887

RCA Graphic Systems Division, P.O. Box 20, Dayton, N.J. 08810

The Singer Company, Friden Division, 97 Humboldt Street, Rochester, N.Y. 14602

Star Parts Company, South Main and East Wesley, South Hackensack, N.J. 07606

Varityper Division, Addressograph Multigraph Corporation, 11 Mount Pleasant Avenue, Hanover, N.J. 07936

GLOSSARY

Aberration. A defect in the image formed by an optical system.

Accents. Diacritical marks placed above or below alphabetic characters.

Accents, Floating. Individual diacritical marks placed above or below any character.

Acuity (visual). The ability of the eye to distinguish small spatial separations and small objects in a visual field. It varies with contrast, luminance, and the kind of object.

Add Thin Space. A method of justifying a line by adding an extra space at the positions of the expandable spacebands.

Alignment. Proper positioning of printed characters.

Alphanumeric Characters. Alphabetic or numeric characters.

Aperture. An opening.

Archival Quality. The ability of processed photographic material to resist deterioration for a long time.

Ascender. The part of an upper-case character that is above the main body of the character, for example, the upper portion of the letters d, f, and h.

Astigmatism. A lens aberration that makes it impossible to focus an optical system sharply on horizontal and vertical lines at the same time.

Automatic Typewriter. A device that types copy in response to signals from a control unit.

Back Lighting. Illumination coming from behind the object.

Backspace. To move an input or output medium backward for a distance of one unit, for example, one character position on a typewriter, one row on punched tape, or one *block* on magnetic tape.

BCD (binary coded decimal). Pertaining to a method of representing each of the *decimal* digits 0 through 9 by a distinct group of binary digits. For example, in the "8-4-2-1" BCD notation, which is used in numerous digital computers, the decimal number 39 is represented as 0011 1001 (whereas in pure binary notation it would be represented as 100111).

Boldface. Type with a heavy appearance.

Cathode-Ray Tube. An electronic vacuum tube containing a screen on which information can be stored or displayed. The abbreviation CRT is frequently used. *Note:* Cathode-ray tubes served as the principal storage medium in some of the early digital computers; they are now the basic component of most display units.

Chad. A piece of material removed in the process of forming a hole or notch in a medium such as punched cards or punched tape.

Chadless. Pertaining to the punching of tape in such a way that no chad results because each hole is only partially perforated. *Note:* Chadless perforation makes the full surface of a punched tape available for interpreting (i.e., printing) the characters represented by the punching, but many high-speed punched tape readers cannot read chadless tape.

Chain Printer. A line printer in which the type slugs are mounted on a chain that moves horizontally past the printing positions. *Note:* Chain printers generally provide more accurate vertical registration than the more commonly used drum printers, and interchangeable chains often permit rapid changes in the size or makeup of the character set.

Chromatic Aberration. A lens defect that makes it impossible to bring different colors into focus at the same time.

Collimate. To operate upon light so that it emerges in bundles of parallel rays.

Console. The device through which an operator or serviceman communicates with an automatic machine.

Contact Print. A photographic print exposed with its emulsion in contact with the negative or positive transparency being copied.

Continuous-Tone Copy. Copy that contains halftones as well as blacks and whites.

Contrast. The difference in brightness between two parts of a visual field.

Copyboard. A flat structure that supports documents being photographed.

CRT. See Cathode-Ray Tube.

Curvature of Field. An aberration of a lens system that causes the image to be focused onto a curved surface.

Definition. The resolution and sharpness of an image.

Descender. The part of a lower-case character that is below the base of the character, for example, the lower portion of the letters j, p, and q.

Diagnostic Routine. A routine that locates a machine or system malfunction.

Diazo Process. A copying process utilizing a film or paper that has been sensitized by diazonium salts. Upon exposure to blue or ultraviolet light, it forms a latent image that can be developed.

Direct-Image Film. Film that produces a negative from a negative or a positive from a positive.

Disk Storage. A type of magnetic storage that uses one or more rotating flat circular plates with a magnetic surface on which data can be stored by selective magnetization of portions of the surface.

Document. (1) A medium and the data recorded on it for human use (e.g., a check, report sheet, or book). (2) By extension, any record that has permanence and can be read by man and/or machine.

Dot-Matrix Generator. A matrix of dots that can be turned on individually to form a character.

Drum Storage. A type of magnetic storage that uses a rotating cylinder with a magnetic surface on which data can be stored by selective magnetization of portions of the surface.

Em. A linear measurement equal to the square of the height of any type size, or the square of the number of points in the point size. *See* Point.

Emulsion. A suspension of light-sensitive materials, for example, silver halides, suitable for use as a photographic coating.

En. One-half of an em.

Enlarger. A device for making a large photographic print of a smaller original.

Field of View. The area seen by an optical system.

Film, Direct Positive. Film that reproduces positive originals as positives and negative originals as negatives.

Film, Lithographic. High-contrast film from which lithographic printing plates are made.

Film, Negative. Film on which images of dark objects appear light and images of light objects appear dark.

Film, Nonperforated. Roll film without sprocket holes.

Film, Orthochromatic. A black-and-white film that is not sensitive to red light, but is sensitive to other colors of the visible spectrum.

Film, Panchromatic. A black-and-white film sensitive to the entire visible spectrum.

Film, Perforated. Roll film with sprocket holes.

Film, Positive. Film on which images of dark objects appear dark and images of light objects appear light.

Film, Reversal. A film that is processed to produce a positive image instead of the customary negative one.

Film, Roll. Film wound on a core, reel, or spool.

Film, Sheet. Film precut into rectangular form.

Filter, Heat. A device that absorbs heat without interfering with the transmission of visible light.

Filter, Light. A transparent device that transmits light of certain wavelengths only.

Filter, Neutral-Density. A device that reduces the transmission of light of all wavelengths equally.

Fixed Focus. Optical instruments whose focal settings cannot be varied.

Fixer. A solution used to remove undeveloped particles from the emulsion, thus preventing further development.

Flip-flop. A device that has two states, for example, a toggle switch.

f-number. The focal length of the lens divided by the diameter of the lens aperture.

Focal Length. The distance from the focal point of a lens to the plane of the image when the focus is infinity.

Focal Plane. The plane on which an image transmitted by a lens is most sharply focused; the surface of the film or plate in a camera.

Fog. A blur on a photographic film which does not represent an image. It may be caused by stray light, poorly compounded processing solutions, or photographic materials that are outdated or have been improperly stored.

Forms Overlay. A method of superimposing ruled forms on the contents of a page.

Foundry Type. Hand-set type cast in a type foundry.

Font. A character set of a specified type style and size.

Galley. A flat tray for the temporary storage and correction of composed type. Often used synonymously with galley proof.

Galley Proof. Proofs taken from a galley, or composed by a photocomposing machine.

General-Purpose Computer. A computer designed to solve a wide variety of problems. *Note:* Most of the current digital computers fall into the general-purpose category because their stored-program capability and the inherent flexibility it provides make them suitable for a wide range of diverse applications in both business and scientific data processing. Contrast with special-purpose computer.

Grain Size. The size of the particles of silver halide in an emulsion. The inherent grain size of microfilm is very fine. Exposure and processing affect grain size.

Graphic Arts Quality. Typographic quality equivalent to that of high-grade typeset matter.

Gutter. The space between the bound edges of adjacent pages.

Halide. A binary chemical compound of a halogen (chlorine, iodine, bromine, fluorine) with a more electropositive element or group. The light-sensitive materials in silver emulsions are silver bromide, silver chloride, and silver iodide.

Hot-Metal Typesetting. Typesetting by casting the characters in typemetal from a set of matrices.

Humidity. The dampness of the atmosphere. Absolute humidity is the weight of the water vapor in a given volume of air, such as grains per cubic foot. Relative humidity is the ratio of the weight of water vapor in the air at a specific temperature to the weight of the water vapor required to saturate the air at that temperature.

Hypo. Ammonium or sodium thiosulfate, agents used to remove unexposed silver halides from silver emulsion film. The term commonly refers to a fixer solution, which may also contain certain acids or hardening agents.

Hypo, Residual. The amount of fixer solution remaining in film or paper after it has been washed.

Image, Latent. The invisible image produced by radiant energy falling on a photosensitive surface. The process of development makes the image visible.

Indent. The amount of white space at the beginning of a line.

Iris. A circular mechanical device that can be adjusted to control the amount of light reaching the film of a camera. It may be located in front of, in back of, or between the lenses.

Italics. Slanted characters.

Justification. Inserting spaces to provide even margins at the left and right sides of a column of type.

Justification Zone. The area at the end of a line within which a machine can cause the line to be justified.

Kern. The overhanging part of a letter.

Keypunch. A keyboard machine used to punch holes in cards or tapes for data processing equipment.

Letterpress. Printing from relief type.

Ligatures. Characters joined together.

Light, Ambient. Surrounding or encircling light; the general illumination or light level in a room or location.

Light-Sensitive Materials. Substances that undergo changes upon exposure to light. The most common light-sensitive photographic materials in film and papers are silver halides, diazo dyes, bichromated gelatin, and the photoconductive materials employed in xerography.

Line Copy. A document recorded essentially in two tones (black and white, brown and buff, etc.) with no intermediate tones.

Line Printer. A machine that can produce a complete line of type in one cycle of operation.

Lower Case. The small letters of a type font.

Luminance. The luminous intensity per unit projected area of a given surface viewed from a given direction.

Magnetic Disk. A storage device; data recorded on the surface of a rotating disk.

Magnetic Drum. A storage device; data recorded on a cylinder having a surface coating of magnetic material.

Magnetic Tape. A tape with a magnetic surface on which data can be stored by selective polarization of portions of the surface. *Note:* The magnetic tape currently in widest use with computers is made of a polyester plastic, is $\frac{1}{2}$ inch in width, is supplied in 2400-foot reels with a diameter of 10.5 inches, and is recorded with 7 or 9 tracks across the tape at a recording density of 200, 556, 800, or 1600 rows per inch.

Magnetic-Tape Unit. A device used to read data from or record data on magnetic tape; contains a tape transport mechanism, reading and writing heads, and associated controls.

Magnification. The linear ratio of the size of the image to the size of the object when the object is seen through or projected by an optical instrument.

Magnification Range. The linear range of magnification in a given optical system.

Matrix Character Generator. A generator that synthesizes characters by ordering the illumination of designated points in the matrix; if the spot diameter is greater than the raster interval, the spots will usually merge to form a continuous character.

Monobath. A single solution that constitutes a combined developing and fixing bath for processing photographic materials.

Multiplexing. The transmission of a number of different messages simultaneously over a single circuit; utilizing a single device for several similar purposes, or using several devices for the same purpose.

Negative. A photographic image in which the light areas of the object represented appear dark and the dark areas appear light.

Neutral-Density Filter. A filter for reducing all colors of light uniformly.

Offset Lithography. A planographic printing process in which the inked image of the page is transferred to an intermediate blanket before being placed on the paper.

Opacity. The quality or state of being impenetrable by light.

Optical System. A system comprising all the parts of a photographic lens and accessory elements that contribute to the formation of an image on a photographic film or on a viewing screen.

Output. (1) Data that has been processed; (2) the state or sequence of states occurring on a specified output channel; (3) the device or collective set of devices used for taking data out of a device; (4) a channel for expressing a state of a device or logic element; (5) the process of transferring data from an internal storage to an external storage device.

Paper, Photographic. A base of high-grade paper coated with a layer or layers of photosensitive material.

Paper, Projection. This term usually denotes a fast photographic paper that is exposed by projecting the image of the film being printed onto the emulsion on the paper.

Paper Tape. Same as Punched Tape.

Paper-Tape Reader. A device that senses data punched as a series of holes in paper tape.

Parallax. The apparent displacement of an object with a change in the position from which it is observed.

Perforated Tape. Same as Punched Tape.

Perforator. A keyboard device for punching paper tape.

Photoelectric Cell (photocell). An electronic device whose electrical output varies in response to incident radiation, especially visible light. It is used in exposure meters.

Photograph. (1) A positive or negative picture obtained by the exposure of a sensitized photographic material in a camera and subsequent processing and printing. (2) Any image recorded on sensitized photographic material.

Photomultiplier Tube. An electronic device that converts light into electrical energy and amplifies it. In microfilming it is used in exposure determination.

Pi. Printer's type that is in disarray.

Pi Character. A character or symbol not usually contained in a font of type.

Pica. A unit of measurement for type matter on a page. One pica equals about 1/6 inch.

Platen. A mechanical device for holding film in the focal plane while it is being exposed.

Point. A unit of type measurement; 1 point = 0.01384 inch = 1/72 in.; 12 points = 1 pica.

Prism. A homogeneous transparent solid, usually with triangular bases and rectangular sides, which reflects or refracts light. When light is refracted by a prism whose refractive index exceeds that of the surrounding medium, the light is deviated or bent toward the thicker part of the prism. Prisms are often used for rotating an image and for producing or analyzing a continuous spectrum.

Processing. The treating of exposed photographic material to make the latent image visible. It consists of developing, fixing, washing, and drying the exposed material.

Projection Printing. A method of exposing a photosensitive surface by projecting an image upon it through an optical system.

Pulldown. The distance film is advanced after each exposure.

Punched Tape. A tape of defined dimensions that can be punched with a pattern of holes in defined positions for the purpose of representing data. *Note*: Punched tapes in common use are made of paper, oiled paper, or polyester plastic. Tapes are usually designated according to the number of holes that can be punched across them. For example, an eight-track tape may have up to eight code holes (plus a smaller feed hole) punched across the width of the tape. Synonymous with paper tape, perforated tape. *See also* Chad, Chadless.

Raster. The area occupied by a projected image.

Read In. To sense information and then transmit it to an internal storage device.

Read Out. To sense information in an internal storage device and transmit it to an external storage unit.

Reduction. The number of times a given linear dimension of an object is reduced when it is photographed.

Reflectance. The ratio of the total radiant energy, as of light, reflected by a surface to the total radiant energy incident on the surface. Also called coefficient of reflection.

Refraction. The deflection of a propagating wave, as of light or sound, at the boundary between two mediums with different densities or refractive indices, or in passage through a medium of nonuniform density.

Reperforator. A device that automatically punches a paper tape from received signals.

Resolution Interval. The separation in mils or millimeters between two adjacent raster spots on the display screen (equal to the raster interval less the spot diameter).

Resolvable Points. The number of discrete points on the display that can be separated and distinguished by the human eye (fewer than the total number of addressable or raster points if the spot-size diameter is greater than the raster interval).

Resolving Power (photographic). The fineness with which a lens, optical system, or film emulsion is able to reproduce the details of an image. It is expressed as the number of lines per millimeter that can be discerned in the image.

Reverse Reading. A reproduction that is a mirror image of the original.

Rewind. (1) A spindle-and-crank device, plus a support, used in pairs to wind film from one reel to another. (2) The act of transferring film from one reel to another to get a different orientation of the film.

Right Reading. An image that is legible in the normal reading position.

Roman. Vertical characters.

Sans Serif. Characters without serifs.

Scale, Gray. A series of gray areas varying discretely or continuously in density at a predetermined rate from black to white. It is used to control the contrast of photographic duplicates. It may take the form of a step tablet or gray wedge.

Serif. Short strokes or embellishments at the ends of the basic character strokes.

Servo Mechanism. A control mechanism that can feed back information and adjust discrepancies during the course of an operation.

Shutter Speed. The length of time between the opening and closing of the camera shutter; hence, the length of time during which light acts upon the film or paper.

Silver Film. Film coated with emulsions containing light-sensitive silver salts.

Skew. The angular displacement of an individual printed character, a group of characters, a magnetic tape row, or other data from its intended or ideal placement.

Slug. A solid line of copy cast in type metal.

Small Capital. Capital letters that are not as high as the normal capitals in a font.

Spaceband. The interword spacing device on a linotype machine.

Special-Purpose Computer. A computer designed to solve a restricted class of

problems, for example, a computer designed specifically for use in a specialized application such as process control, message switching, or missile guidance. Contrast with general-purpose computer.

Speed. Used variously for the sensitivity of a photographic layer, the maximum aperture of an objective lens, the chemical efficiency of a processing solution, or the timing of a shutter. There is an American Standard for the speed of film, which is generally based on the reciprocal of the exposure required to produce a certain fractional gradient or density.

Spherical Aberration. An optical defect of refracting and reflecting spherical surfaces in which light rays from one axial point, but incident on the surfaces at different distances from the optical axis, do not come to a common focus.

Splice. A joint made by cementing or welding two pieces of film or paper together so that they will pass through a camera, processing machine, projector, etc. as a single piece. Cemented splices (lap splices) are made by lapping one piece over the other. Weld or heat splices (butt splices) are butted together without overlap. Some butt splices also use tape.

Sprocket Holes. Holes punched in a paper tape or in one or both longitudinal margins of a continuous form to facilitate feeding of the tape or form.

Stabilization. A photographic technique for the fast processing of prints and negatives for temporary use. A stabilization bath is substituted for the fixing bath and the undeveloped silver halide is not removed from the film or paper, but converted into stable colorless compounds. The products of the process are sufficiently resistant to heat, light, and moisture for their purpose.

Stop Bath. A dilute acid solution that stops the development process by neutralizing the alkaline developer on the photographic film or paper as it leaves the developing bath.

Tape Transport. A mechanism that moves tape past one or more heads in a controlled manner, as in a magnetic-tape unit.

Tape Unit. A device containing a tape transport, reading and writing heads, and associated controls.

Teletypesetting. A system whereby all functions of a linotype are controlled by 6-level tape.

Transistor. An electronic device that uses semiconductor properties to control the flow of currents.

Translucent Screen. A sheet of specially prepared (ground, coated, etc.) glass or plastic used in microfilm readers to present a visible image. The image is projected onto the back of the screen and seen on the front.

Transmitted Light. Light that passes through a transparent or translucent body.

Transparency. An image on a transparent base; it may be viewed by transmitted light or used to make copies.

Type Size. The body size of a font of type, usually expressed in points.

Ultraviolet. Of or pertaining to the range of radiation wavelengths from about 4000 angstroms, just beyond the violet in the visible spectrum, to about 40 angstroms, at the border of the x-ray spectrum.

Underdevelopment. Insufficient development of sensitized photographic material, caused by too short a developing time, a weakened developer, or too low a temperature.

Underexposure. Insufficient exposure of sensitized photographic material, caused by insufficient illumination, too short an exposure time, or too small a lens aperture.

Upper Case. Capital letters.

Vesicular Film. Film in which the light-sensitive element is suspended in a plastic layer, and which upon exposure forms a latent image by creating strains within the layer. Heating the plastic layer releases the strains and makes the latent image visual. When the layer cools, the image becomes permanent.

Width Plug. A device that stores character-width information in some type-setters.

Xerography (electrostatic). A dry photographic process in which a latent electrostatic image is formed by the action of light on a photoconducting insulating surface. The latent image may be made visual by various methods; in one, charged resinous pigmented powder is applied to the plate and is attracted to the latent image. The powder particles may be applied and fixed to paper or some other medium.

Zirconium Lamp. A special high-intensity point-source lamp. It is useful because of its concentration of the light source and because its emanation of long-wavelength light (heat) is low.

Zoom Lens. A lens with movable optical elements so that an object can be kept in focus while the focal length of the lens is being changed. Thus the size of the object can be varied while the camera or reader remains in the same position.

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